SCIENCE

FRIDAY, JUNE 4, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ELECTRICAL PHOTOMETRY OF STARS[1]

IN measures of the light of stars there are some advantages and some drawbacks as compared with photometric work in the laboratory. First of all, we are not concerned with absolute measures of intensity, but what we want to know is how the light of a heavenly body varies. If the light is constant, there is not much to be learned, but if it changes, we may infer a great deal from the law of variation. In laboratory and commercial photometry, it is customary to measure what may be called the visual brightness of a source of light, but with the stars it is immaterial for many purposes whether we study the changes of the red, or the blue, or any other part of the spectrum, though in fact any complete stellar photometry should include measures in all regions, infra-red, visible and ultra-violet.

The chief disadvantage in stellar photometry is that the stars are so faint that it is usually not feasible to expand their images out into surfaces, and most forms of stellar photometer depend upon comparisons of two point images by the eye. Although the eye is a wonderful instrument, especially in the range of intensity over which it may be used, the limit of accuracy attained by looking first at one light and then at another is much the same as though instead of using a balance we should weigh objects by lifting them in our hands. It is safe to say that no observer has ever been able to get visual results accurate to 1 per cent., and in the best measures there are occasional errors of 10 per cent., 20 per cent. and even more. It was hoped that the introduc-

[1] Read at the meeting of the National Academy of Sciences, April 20, 1915.

tion of photography would bring greater accuracy in stellar photometry, but at present the errors of the best photographic measures and the best visual ones are about the same.

The use of the property of selenium as a basis of some form of photometer has been made by various investigators, but not many have tried it on faint objects. The principle of converting a light effect into an electrical one is quite simple, for what we call a selenium cell is a bridge or resistance. Light from a bright source like the sun, falling upon a selenium element of 1,000,000 ohms, will reduce the resistance to say 20,000 ohms or one fiftieth of the original. For faint lights there are some special electrical connections which give the best arrangement, but let it suffice to state that as used with our telescope a selenium cell is connected as one arm of a Wheatstone bridge, that we use a d'Arsonval galvanometer, and current is supplied by a few dry cells.

The nature of the problem becomes apparent when we state that the image of a second magnitude star, say the Pole Star, near the focus of a 12-inch telescope objective gives the same surface illumination on a selenium cell that would come from a candle at 150 meters' distance, without any intervening lens. Therefore, to measure the light of such a star with a probable error of 1 per cent. is equivalent to the detection of a candle at 1,500 meters, or roughly a mile. In theory, to work with faint lights we might increase the voltage and use a very sensitive galvanometer, but unfortunately selenium is not so uniform in its action that the sensitiveness of an apparatus can be increased without limit, and the peculiar irregularities of behavior have prevented selenium from being of wider application. It is especially susceptible to temperature changes, and after exposure to light requires considerable time for recovery. It becomes more sensitive and extraordinarily more regular with decrease of temperature, and conditions are probably best when a cell can be maintained at a uniform temperature of about —20 degrees Centigrade.

We have found it best to keep an ice pack about the cell at the end of the telescope for work in moderate or warm weather, and the whole apparatus is wrapped up in a blanket. The observer, looking through the eyepiece which receives a portion of the light from a star, makes the exposures while a recorder in another room reads the galvanometer. As this second room may be heated, it is our custom, especially in winter, to reverse astronomical practise by having the chief observer write down the notes, while the assistant is sent up into the cold dome to manipulate the telescope.

There is another device, however, which bids fair to supplant entirely the selenium photometer, namely, the photo-electric cell made from one of the alkali metals. The sensitive metallic surface is in an exhausted tube with a small quantity of inert gas, and the effect of light is to release electrons from the surface, which ionize the gas, and thus a current is produced. We are fortunate in having several of our physicists at Illinois interested in photo-electric cells, especially Professor Jacob Kunz, and it is in the laboratory where the really important improvements are made. Only recently we managed to produce a cell which is twice as sensitive as anything we had before, and this amounts to the same thing as though some good fairy had suddenly doubled the light gathering power of our telescope. The great advantages of the photo-electric cell over selenium are first the freedom from irregularities, and next the very short time of recovery. It is too

soon to estimate the relative sensibility but at least a tenfold improvement over the best obtained with selenium is expected with the new apparatus.

We may now consider some of the more strictly astronomical features of the work, and the results to be mentioned were all secured with the selenium photometer. There is one star in the sky which for a hundred years has aroused more interest than any other, namely, the well-known variable, *Algol*. Once in 69 hours the star is found to lose two thirds of its light, due to the eclipse of the main body by a large and relatively faint companion. This principal eclipse has been known and studied for a century, but it has often been pointed out that if the eclipse theory is true then, unless the companion is entirely dark, there should be a second eclipse when it passes behind the main body. This decrease in light midway between the primary eclipses was sought for in vain by visual observers, but observations with the selenium photometer established the presence of a diminution amounting to 6 per cent. There is also a continuous variation between minima, showing that the companion is brighter on the side toward the primary, partly because of reflection, but chiefly because of the heating effect. As the brighter body gives off more than 200 times as much light as the sun, it is easy to show that on the surface of the companion nearest the primary there is received more radiation per unit area than is emitted by the sun, and even on its fainter side, this body, which has often been called dark, has much more than the solar intensity. The scale of miles is not exactly known, but each body has slightly more than the solar diameter, the companion being a trifle larger, and the distance between centers is less than five times the average radius of the spheres.

Another case is the second magnitude star, β *Aurigæ*, which was one of the first of the so-called spectroscopic binaries to be discovered. As the spectrum lines are single and then double on successive nights, we have a system of two bodies with a period of revolution of about four days. The bodies will be in conjunction as seen from the earth when the spectrum lines are single, and this is the time to look for eclipses. The photometric observations show that exactly at the predicted times the light of the system decreases 7 per cent., the eclipses following each other at intervals of half the period. We have then a twin system, each component having 2.6 times the diameter of the sun, 2.4 times the mass, and being 1/7 as dense. The surface brightness of each body is at least 12, and possibly 25 times that of the sun, the total light of the system being 150 to 300 times the solar light. Therefore the sun if placed beside these dazzling objects would look like an insignificant dark body.

The next star which has been observed is δ *Orionis*, the right hand one of the three in the Belt of Orion. This object has given us a great deal of trouble, and we have spent something like two hundred hours at the telescope in an effort to smooth out some of the irregularities in the light curve. There are two eclipses, one of 8 and the other of 7 per cent., showing that the companion is nearly as intense as the primary. There is also a variation due to the ellipticity of the orbit, the two bodies being brighter when they are nearer together as a result of a tidal or heating effect. The larger body must have 5 times and probably does have 15 times the solar diameter, while the companion is of half the linear size of the primary. The total mass of the system may be 20 times the sun's, and we can say definitely that the mean density of the system is 0.006 on the solar standard, that is, the bodies average only 6 times as

dense as air. A fair estimate of the total light is that it is equal to 5,000 suns.

These three stars, *Algol*, *β Aurigæ* and *δ Orionis* represent three types of eclipsing binary. The first has a large faint companion, in the second there are twin components, while in the last case the bodies are unequal in size but nearly equal in intensity. As these were actually the first three stars studied with the selenium photometer, and something new came out of each, it is evident that there is plenty of work to be done on similar objects of which there are thousands in the sky. There are at least two other variables which we have picked up, *α Coronæ Borealis*, and the bright star *Spica*.

In fact the large proportion of stars which are variable brings up a number of questions. We may study a large number of stars and find a certain number of eclipsing variables. The proportion of variables gives the probability of such discoveries in a further search, but also we can say that for every variable found there are a definite number of other binary systems the planes of whose orbits are inclined so that we miss the eclipses altogether. From considerations of this nature, it has been possible to conclude: The preponderant type of close binary with components of the same order of size, and of equal or unequal brightness, consists of bodies whose distance between centers is approximately 5 times their average radius, whose period of revolution is about 4 days, and whose mean density is 1/20 that of the sun. Systems of greater or less relative separation are not so numerous, or we should find more of them among the eclipsing variables. This particular discussion is based upon the variables which have been found by visual and photographic methods, but there is abundant field for work in the same line for the electrical photometers. The point to emphasize is that not only will systematic studies of stars which vary in light give us direct information, but indirectly we can draw far reaching conclusions about stars which are apparently constant.

Of the many other problems in photometry which may be attacked with good prospect of success may be mentioned the case of our sun, which, according to Abbot, is a variable star. There can not be the slightest doubt of the variation, for a single sunspot is enough to change the total light, the only question is how much? However, the changes in the light are probably measures of the general activity of the sun, rather than of local disturbances like spots. In direct measures of the sun's radiation the chief difficulty lies in the proper allowance for the absorption of the earth's atmosphere, but this trouble may be eliminated by comparing the reflected solar light from one of the planets with the light of a number of stars. Probably Saturn is a good object for this purpose, as there are few markings on its surface, but Uranus would be still better on account of its slower motion, and the greater number of comparison stars which could be found for it.

In the present paper, an attempt has been made to indicate in a general way the work we are doing, and evidently there is considerable variety in it. The production of a good electric cell, and its proper installation in a photometer is a problem in experimental physics, and any success which has come has been through the efforts of several men of widely different training and interests. In the experiments with selenium I had the collaboration of Dr. F. C. Brown, and now, with photo-electric cells, Professor Jacob Kunz is doing his best to perfect our methods. By combining our knowledge and experience we have been able to carry on researches which would have been hopeless for one man

alone. And so it seems to me that a report on such joint work is peculiarly fitting before this academy, which I assume, if it stands for anything, stands for cooperation and mutual help among men of science.

JOEL STEBBINS
UNIVERSITY OF ILLINOIS OBSERVATORY

MR. EDISON'S SERVICE FOR SCIENCE[1]

ALL the world is indebted to Mr. Edison, but the portion of it that is under special obligation is the educational world, particularly the schools of technology. It is not merely that he has helped them by criticism and constructive suggestion; it is not merely that by financial assistance he has enabled them to carry on scientific investigations in fields that he has cultivated with such remarkable success; but it is mainly because he has himself been for a generation an educational institution of the first rank. As much as any other school he has had a profound influence throughout the country in arousing in the minds of young men some sense of the limitless possibilities of science when devoted to the service of man and some appreciation of the conditions under which great problems of industrial improvement must be attacked if lasting victories are to be won. It has been a great thing for America to have such a central figure in this age of applied science—a man with such a hold on the popular imagination as to force men to watch what he is doing, for in studying Edison there can not fail to be revealed something of the underlying forces that mould the world of modern industry.

I have said that Mr. Edison is an institute of technology or a school of applied science. Such an institution, if it be worth anything, stands preeminently for three things: for belief in science and in its powers of service, for understanding and appreciation of the method of science, and in the third place, for faith in the gospel of work.

Edison more than any one else in this country has taught men to see something of what science can do. It would, of course, be impossible on such an occasion as this to enumerate the accomplishments of a life so rich in great achievements. With such an embarrassment of riches, it is scarcely practicable even to single out a few of his great accomplishments. Many of you are familiar with what he did in the early days by way of improving the duplex and quadruplex systems of telegraphy, you know of his invention of the contact transmitter and his development of the loud-speaking telephone, of his marvelous invention of the phonograph (Edison being the first to make a record that would *reproduce* sound), you think of his wonderful work in 1878 and later years in developing the incandescent lamp, and you realize that he practically made the *whole* incandescent system, not only inventing the lamp, but turning his attention to all its adjuncts, improving the dynamos for such work and providing the necessary means for the distribution of power over large areas. You recognize that he laid the foundations for the design of central power stations and that his Pearl Street Station was a landmark in the history of science. His work in this field is truly phenomenal, the three-wire distribution, the system of feeders entering the network of mains at different points, the underground conductor system, the bus system in stations, the innumerable accessories of switches, fuses, meters, etc., that he provided are each achievements that would make the fame of any individual. You appreciate the remarkable character of his later work in developing the apparatus of moving pictures and you agree that what he has done still more recently in perfecting the alkaline storage cell is a splendid example of energy and persistence in attacking a difficult problem. Thinking of all these things, you can not fail to be impressed with two things—the enormous range of his activities and the wonderful simplicity of many of his devices. After all, simplicity of device is always the sign of the master, whether in science or in art. In studying Edison you have something of the same impression as in studying Newton

[1] Address at the Civic Forum, New York, May 6, 1915, on the occasion of the presentation of its medal for public service to Mr. Edison.

—you are surprised how easy are the steps. Some one asked Lord Kelvin why no one before Edison had invented so *simple* a thing as the feeder system. "The only reason I can think of," he said, "is that no one else was Edison." As to the range of his activities, he has been associated in some way with so many of the great modern developments that people sometimes speak as if he had invented *everything*, even electricity itself, or if they do not go to this length, they find it necessary to explain why he did not invent this or that. The fact that his name is not intimately associated with one of the great modern achievements—the development of the aeroplane—has called forth numerous ingenious explanations. One of these is that it is due to discouragement resulting from his experience as a boy with an experiment that has often been described. It is said that he induced another boy to swallow large quantities of Seidlitz powders and encouraged him to believe that sufficient gases would be generated to enable him to fly. Whether this be history or fable I know not, but, seeing that he has done so much, we need not spend much time in wondering why he has not done more. Nor need we attempt the impossible in the effort to measure the debt that mankind owes to him. Such statements as have been made to the effect that his inventions have given rise to industries that employ nearly a million of men and thousands of millions of capital really give no adequate sense of the value of his achievements, although they may be of some use as a very rough indication of the scale of his activities.

Not only has he shown his faith in science by great achievements, but he has proved himself a great force in education by giving so brilliant an exhibition of the *method* of science, the method of experimentation. When we get to the root of the matter we see that nearly all great advances are made by improvements in method. There is no evidence that men are abler in the twentieth century than they were in the Middle Ages, but they have learned a new method. "It was in Boston," said Edison, "that I bought Faraday's works, and appreciated that he was the master experimenter." It is interesting to think what Edison's appreciation of this fact has meant for the world. His popularity and the place that he holds in the public esteem have forced newspaper men to write so much about him that they have often had to rely upon imagination. It is not surprising, therefore, that there are many current myths regarding Mr. Edison. The popular desire for dramatic contrast suggests that to reach the heights of prosperity and public esteem that he has occupied for long, he must have risen from the depths of poverty and neglect. This is a pure myth, harmless, perhaps, and possibly useful as a spur to ambitious youth. A less innocuous myth is the one that sets him up as a "practical man" in the narrow sense. It is true that he has described himself as "pure practise" in distinction from Mr. Steinmetz whom he has called "pure theory," but this, of course, was a joke. Newspaper men have expanded it so as to make it appear that Edison knows nothing about science, cares nothing for the achievements of the great experimenters and thinkers who have preceded him, and merely tries everything that he can think of until he happens upon what he is seeking. Few things more absurd could be suggested. He is no slave to theory; he is ready, as every scientific man is ready, to try anything that seems reasonable, but practically always he has what seems to him a good reason for everything that he tries. In the rare cases where he has tried blindly, it has been because there was absolutely no light.

Just one more observation and I am done. His other great contribution to the progress of education has been his constant insistence on the gospel of work. Genius was long ago described as "an infinite capacity for taking pains." We all feel this to be inadequate, and Edison has put the underlying thought more accurately and more picturesquely by his aphorism that "genius is one per cent. inspiration and ninety-nine per cent. perspiration." Contrary to the general notion, very few of his inventions have been the result of sudden inspiration. Practically all have been evolved by slow and gradual processes. His day is

said to be a twenty-four-hour day, and he is always working when there is anything to do. Weeks and months and sometimes years of tedious experimenting, dauntless patience and unflagging industry, have marked his onward march to victory from the beginning until now. His is a splendid example of scientific pertinacity rarely if ever surpassed in the history of human achievement. He has won and held the admiration of the world; and his influence must remain as a permanent source of inspiration both within the schools and without.

RICHARD C. MACLAURIN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE PROCEEDINGS OF THE NATIONAL ACADEMY AS A MEDIUM OF PUBLICATION

THE establishment of monthly *Proceedings* by the National Academy of Sciences, in which the first announcements of new advances are made, has met with instant recognition by a wide circle of investigators. Eighty-three original papers have appeared in the first five numbers, and the inflow of manuscripts is continually increasing. Many university departments and several research laboratories, namely, the Rockefeller Medical Institute, the Lick and Yerkes Observatories, the Nutrition, Experimental Evolution, and Marine Biological Laboratories and the Mount Wilson Observatory of the Carnegie Institution, and the Research Laboratories of Harvard University and the Massachusetts Institute of Technology have already indicated their intention of adopting the *Proceedings* as their regular medium for announcing new and important results. The success of the *Proceedings* is therefore amply assured.

The need of a national journal representing the joint interests of science as a whole and providing for the prompt publication and wide distribution of the chief results of American research has been felt in every department of science. The vigorous developments of science in recent years have carried us past the time when all of the special journals could assure early publication; and their very multiplicity has stood in the way of wide foreign circulation. Four leading American journals of biology have an average paid foreign circulation of 93 copies (maximum 109, minimum 77). This is not due to any inferiority in quality, as all of these journals are of the first rank. Nor does it indicate that they are undesirable places to publish. On the contrary, they have come into existence to meet a natural demand, and they certainly afford the most satisfactory means of publishing extended technical papers, intended for investigators in the fields which they represent. The *Proceedings* are expected to supplement them and should aid materially in increasing their circulation; for authors are requested to adopt the uniform practise of referring in each article to the journal in which the details of their investigations will subsequently appear. Such frequent references, seen by a wide circle of readers, will soon have their effect.

It is in the character and scope of their circulation that the *Proceedings* will perform their best service. Truly national in character, with a membership elected on equal terms from all sections of the country, and serving as the representative of the United States in the International Association of Academies, the National Academy of Sciences is peculiarly fitted to bring its publications to the attention of foreign readers. In Europe the academy is regarded as the natural representative of American research, and this fact gives at once to the *Proceedings* an authoritative standing among foreign investigators.

As foreign secretary of the academy, I have been called upon to prepare, with the cooperation of the editors representing all departments of science, a comprehensive list of foreign exchanges. Every effort has been made to secure a well-balanced distribution. From the extensive data in *Minerva* relating to academies, societies, universities, seminars, general and special libraries, laboratories, observatories, museums, botanical and zoological gardens, biological stations, geological surveys, and other centers of study and research, a representative group of about 900 foreign institutions has been compiled. In preparing this mailing list use has also been made of the ex-

change lists of the Royal Society and other similar bodies. Bibliographical bureaus, yearbooks and journals giving special attention to abstracts and reviews have been included in the mailing list. Chief stress, however, has been laid on placing the *Proceedings* in the leading research centers, including university departmental libraries when these are of sufficient significance. In many cases it by no means suffices to send the *Proceedings* to a general university library; they must also be readily accessible in the departments and seminars where the work of research is mainly done.

Such a distribution will obviate the necessity, felt by some American investigators, of publishing their papers in foreign journals. They may now secure the circulation they desire by presenting their chief results in the *Proceedings* and the details in an American special journal.

Publication in the *Proceedings* will also have the advantage of bringing researches in one department of science to the attention of scholars in other departments, who would otherwise fail to see them. In a period when many of the greatest advances are being made in the fields lying between the traditional branches of science, and when the wide adaptability of various methods of research is being repeatedly demonstrated, it is unnecessary to dwell upon this point. It may only be mentioned by way of example that a well-known physicist has recently spoken to me of the advantage of seeing in the *Proceedings* short astronomical papers which he would not have opportunity to read in their more extended form.

As readers in widely separated fields may be expected, authors should make their papers as clear and as readable as possible. The papers should open with a statement of the purpose in view and the broader bearing or antecedent conditions of the investigation, and should close with a summary of results. The papers should be short, of two to six pages in length; but they should not be mere abstracts, devoid of interest except as a bare statement of facts, but complete and well-rounded articles, grounding their conclusions upon a substantial basis of calculations, observations or experiments, though free from all unnecessary technicalities and details and from extensive tabulations of data. They should always appear in the *Proceedings* prior to their publication in special journals.

While serving the purposes already enumerated, the *Proceedings* will attempt also to contribute to the popularization of scientific research. Nothing could be more injurious to the public appreciation of science than its current distortion by the newspapers. Mr. Melville E. Stone, general manager of the Associated Press, feels this no less keenly than the men whose work is so often misrepresented by reporters. He would heartily welcome means of securing reliable statements of progress in science, expressed in clear and unsensational form, for use by the Associated Press. By an arrangement with him the editors of the *Proceedings* will attempt to supply suitable statements, based upon such articles as are of sufficient general interest and importance. Authors who prefer not to have their articles used in this way may notify the editors. Every effort will be made to secure clear and dignified statements, expressed whenever possible in the author's own language. The experiment is not without its difficulties; and success may not be attained at once. It nevertheless seems important to make the attempt, in order to counteract in some measure the present unfortunate condition of affairs.

Provision will also be made for a review of the papers published in the *Proceedings* in the widely circulated journals of general science. Thus such a review will appear regularly in the columns of Science; and an arrangement has been made with the editor of *Nature* for the publication of reports on the monthly issues of the *Proceedings*. The *Scientific American*, which is conducted in a very creditable manner, will also, through an arrangement made with its managing editor, Mr. Waldemar Kaempfert, present accounts of the articles of popular interest.

In closing this paper, in which I have tried to indicate how the *Proceedings* of the National Academy may serve as a prompt and

convenient means of announcing and circulating the chief results of research, I should perhaps add a word to those who have not yet contributed to their pages. Papers are accepted solely on their merits, from non-members as well as from members of the Academy. To facilitate the work of the editors, it is required that papers by non-members be transmitted to the managing editor by a member, but neither the manner of printing nor the sequence of the papers in the *Proceedings* is affected by this fact. Further information may be obtained from Professor A. A. Noyes, chairman of the board of editors, Massachusetts Institute of Technology, Boston.

GEORGE ELLERY HALE

THE SEATTLE MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE vote recently received at the secretary's office being overwhelmingly in favor of the Great Northern Railroad, which stops at Glacier National Park, arrangements have been made with this road for the party to leave Chicago at 5:05 P.M. Thursday, August 26. One and one half days will be spent at Glacier National Park, and Seattle will be reached at 6 P.M. August 30. August 31, September 1 and 2 will be spent at Seattle, and on the evening of September 2 the party will take a special train to Mt. Ranier National Park, where they will remain on Friday, September 3, leaving there that evening and arriving at Portland the following morning; spending the day in Portland as the guests of the Oregon Section; leaving Portland Saturday night, passing through the Mt. Shasta and Mt. Lassen region on Sunday and arriving in San Francisco Sunday evening. At San Francisco the party will break up, returning via any route they choose.

The round-trip rates from Chicago are $80. The sleeping car rates from Chicago to San Francisco by the route of the special train are as follows: Lower berth, $22.50; upper berth, $18.00; compartment, $63.00; drawing room, $80.00.

There will be an additional Pullman charge to Mt. Ranier National Park, which will, however, be little if any more than hotel accommodations should the party remain in Seattle. There may be also a small additional Pullman charge for holding the train at Glacier and Portland. There will be a charge of $12.50 for 114 miles of automobile trip and 20 miles of launch trip in Glacier National Park, and $5.00 for the side trip through Tacoma to Mt. Ranier National Park. The hotel rates in Glacier National Park are from $3.00 to $5.00 per day on the American plan. Those who wish may spend the night at "Many Glacier Camp" instead of at "Going-to-the-Sun Camp" on the night of August 29, which will give them plenty of time to take a side trip to the wonderful Iceberg Lake on the morning of the 29th.

As the Great Northern passes the very gates of Glacier National Park, a trip through the park is a very simple matter. The tremendous mountain land of Glacier National Park sits high up in the Rocky Mountains of northwestern Montana and stretches to the Canadian border. The park is of 1,525 square miles extent, with a veritable army of magnificent peaks rising from 8,000 to 10,000 feet, with their bases thickly timbered and their limestone crests painted in many colors—reds, browns, blues and purples. On the tops of these mountains are 20 glaciers every bit as inspiring as those ice fields which Americans have been crossing to Switzerland to see; of these the great Blackfeet Glacier has an area of five miles. There are more than 250 glacier-fed blue mountain lakes. So well have the most important sections of the park been linked by government auto stage roads that it is now possible to see within a short time what formerly required weeks to visit.

So much has been written about the wonders of Mt. Ranier National Park that there is little need to add detail here. The following quotation from the *Travelers Magazine* will be sufficient: "Read as much about it as you will, see it pictured a thousand times, and believe all the tales you hear of it, and on going there you will find that it has been underrated. It is hard to believe when you see it. Mt. Ranier is the highest mountain in the United States and has a glacial system greater than that of the whole Swiss Alps. The National

Park has an area of somewhat more than 200,000 acres. How bald and uninspiring are statistics! Let it be said, rather, that this is the most beautiful place in the world."

Interesting, illustrated literature may be obtained describing Glacier National Park from H. A. Noble, general passenger agent, Great Northern Railway, St. Paul, Minn., and of Mt. Ranier National Park from the Chicago, Milwaukee & St. Paul Railway, Chicago, Ill., and Seattle, Washington. The following beautifully illustrated publications may be obtained from the superintendent of documents, Washington, D. C., for the price noted:

Some Lakes of Glacier National Park, 10 cents.

Glaciers of Glacier National Park, 15 cents.

Origin of the Scenery Features of the Glacier National Park, 15 cents.

Glacier National Park, with map (Bulletin 600 U. S. Geological Survey), 30 cents.

Mt. Ranier and Its Glaciers, 15 cents.

It is of the utmost importance for the success of this trip that the secretary be informed at the earliest possible moment of the intention of those intending to be present, the accommodations needed and the number of tickets required. In this connection it should be noted that in purchasing tickets free side-trip tickets to the San Diego Exposition from Los Angeles; to Colorado Springs from Denver; to Salt Lake City from Ogden, may be had, by any member of the party returning through these cities if the request for this side trip is made at the time ticket is purchased.

Members of other scientific societies and friends recommended by members of the society will be gladly received on the special train.

Chas. L. Parsons,
Secretary

Washington, D. C.,
Box 505

SCIENTIFIC NOTES AND NEWS

A banquet in honor of Dr. William T. Councilman, professor of pathology in the Harvard Medical School and formerly of the Johns Hopkins Medical School, was given in Baltimore, on May 13, by his colleagues and former students. At the banquet a portrait of Professor Councilman was presented to him.

Professor R. Newstead, of the Liverpool School of Tropical Medicine, is in France, prosecuting entomological investigations from the point of view of military sanitation.

Professor Vernon L. Kellogg, of Stanford University, sailed for Liverpool on May 29 to join the commission for relief in Belgium. He will spend the summer in volunteer work for the commission.

Dr. Frank G. Speck, of the department of anthropology of the University of Pennsylvania, is on a leave of absence for his summer's work in the field. He will spend a large part of the summer among the Montagnais and Mistassini Indians, who are tribes of southern Labrador, for the purpose of completing his collection of texts in the native languages of three tribes.

Dr. John Ulric Nef, professor of chemistry and head of the department at the University of Chicago, delivered a lecture on May 21 before the Phi Lambda Upsilon, honorary chemical society of the university. His subject was "The Chemistry of Enzyme Action."

Dr. Richard M. Pearce, professor of research medicine at the University of Pennsylvania, addressed on May 21 the Academy of Medicine of Cleveland, his subject being "The Relation of the Spleen to Blood Destruction and Regeneration and to Hemolytic Jaundice." Following the lecture a smoker was given at the University Club in honor of Professor Pearce by the heads of the departments of medicine and of surgery and of the various laboratories of the school of medicine of Western Reserve University.

The Swarthmore lecture of the Society of Friends, London, was given on May 18, by Professor Silvanus P. Thompson, who spoke on "The Quest for Truth."

In memory of Dr. Edith J. Claypole, research associate in the department of pathology of the University of California, who died on March 26, 1915, friends of the university have offered an annual gift of $1,200 to maintain the position of research associate in

pathology, and have made definite provision for an endowment sufficient to yield this income. The immediate purpose of the position is to be a continuance of investigations in which much valuable work has already been accomplished by Dr. Claypole, in collaboration with Dr. F. P. Gay, professor of pathology in the University of California, in regard to improved methods for immunization against typhoid and methods for the treatment of that disease.

THE name of Curie, in honor of the discoverers of radium, has been given to a small park formed by the tearing down of the old rue Dauphine in Paris.

AT commencement at the University of California, honorary degrees were conferred on Chancellor David Starr Jordan and President John Caspar Branner, of Stanford University, and on the Hon. Alfred Deakin, of Melbourne, the first prime minister of the commonwealth of Australia.

AT the recent annual meeting of the Association of American Physicians, held in Washington, Dr. Henry Sewall, Denver, Colo., was elected president, and Dr. George Dock, St. Louis, vice-president.

DR. LLEWELLYS F. BARKER, of the Johns Hopkins Medical School, was elected president of the American Neurological Association at the meeting held recently in New York City.

THERE is exhibited at the Royal Academy this year a portrait of Sir Archibald Geikie, painted by Mr. R. G. Eves for presentation to the Royal Society.

THE Pereira medal of the British Pharmaceutical Society has been awarded to Miss Dora F. White, and its silver and bronze medals to Mr. A. J. Somer and Mr. R. W. Bowles, respectively.

DR. SAMUEL G. DIXON, Philadelphia, whose renomination as Pennsylvania state commissioner of health was sent to the senate by the governor, on May 17, was confirmed on May 18. This is the third reappointment of Dr. Dixon to this position which he has now held for nearly ten years.

DR. ROSCOE W. HALL has succeeded Dr. David K. Henderson as resident physician of the Phipps Clinic of Johns Hopkins Hospital. Dr. Henderson has been appointed superintendent of the Royal Asylum of Scotland, Glasgow.

MR. G. MASSEE has retired from his position as head of the cryptogamic department in the herbarium at the Royal Botanic Gardens, Kew.

A DEPUTATION from the Royal Society and the Chemical Society was received by the presidents of the boards of trade and education on May 6. The deputation was introduced by Sir William Crookes, president of the Royal Society, and Professor W. H. Perkins, Sir William Tilden, Professor P. Frankland, Professor W. J. Pope and Dr. M. O. Forster spoke in support of memorials from the two societies, indicating the steps which might be taken to improve the status and efficiency of the chemical industries and those engaging in them in the United Kingdom.

THE *Irish Naturalist*, as quoted in *Nature*, states that the following naturalists in Ireland are among those who have been given commissions in the army: Professor Gregg Wilson, professor of zoology, and Dr. A. R. Dwerryhouse, lecturer in geology, Queen's University, Belfast; Professor H. A. Cummins, professor of botany and agriculture, University College, Cork; Mr. C. M. Selbie, of the National Museum, Dublin; Mr. G. P. Farran and Mr. A. B. Hillas, of the Fisheries Office; Mr. H. T. Kennedy and Mr. R. L. Valentine, of the Geological Survey.

MR. CHARLES H. MARTIN, of Abergavenny, was killed in the war on May 3 at the age of thirty-three years. He was known for his researches on the protozoa.

ACCORDING to the *Revue Anthropologique*, two noted French pre-historians, Joseph Déchelette and Captain M. Bourlon, have died at the front. Déchelette will long be remembered for his great work entitled "Manuel d'archéologie préhistorique, celtique et gallo-romaine," of which the first volume appeared in 1908 and the third part of the second and last volume in 1914, only a short while before

the outbreak of the war. Captain Bourlon, an enthusiastic and gifted explorer of the paleolithic French caves, had written a number of valuable papers based on his field work.

Lady Huggins, who died on March 24, leaving an estate valued at about $60,000, made, as we learn from *Nature,* the following bequests, among others: A sum not exceeding £1,000 to the Bedford College for Women (University of London); £500, and, if her estate is sufficient, a further sum of £500 for the erection of a memorial in St. Paul's Cathedral to the memory of her husband; £1,000, and if her estate is sufficient, a further sum of £1,000 to the City of London School, Victoria Embankment, for the endowment of a scholarship for the study of astronomy, tenable at Cambridge, to be called the "Sir William Huggins" Scholarship; and a sum of not more than £300 for finishing, editing and illustrating the book on which she was engaged, being the life of her husband. The residue of the estate, if any, is left to the City of London School.

The department of physiology of Columbia University had recently on exhibition in the students' reading room at the College of Physicians and Surgeons, some of the books belonging to the valuable medical library of the late Professor John G. Curtis, which has been recently acquired by the department. These books comprise first editions or early copies of the leading classical writers on physiology and medicine, and include Hippocrates, Galen, Rufus of Ephesus, Aretæus, Soranus, Ætius, Rhazes, Haly ben Abbas, Avicenna, Mondino, Vesalius, Cesalpino, Eustachius, Colombo, Bonaciolus, Varolius, Vidius, Wharton, Valsalva, Van Helmont, Mayow, Harvey, Riolan, Malpighi, Leeuwenhoek, Hooke, Swammerdam, Sanctorius, Vieussens, Aselli, de Graaf, Highmore, Brunner, Stensen, Peyer, Huysch, Lieberkühn, Hales, Santorini, Morgagni, Galvani, Lancisi, Whytt, John Hunter and others.

The Ohio Academy of Science at its annual meeting held recently in Columbus voted to deposit its collection of books, pamphlets, periodicals and other publications of the society in the library of the Ohio State University.

The American Climatological and Clinical Association will hold its thirty-second annual meeting in San Francisco on June 18 and 19, under the presidency of Dr. Henry Sewall, Denver.

On June 26 there will be a New York State civil service examination for special assistant in chemistry, Psychiatric Institute, Ward's Island, New York City, at a salary of $1,200. Candidates will not be required to appear at any place for examination, but will be rated on education, special training, experience and personal qualifications as shown by their sworn statements and by answers to inquiries which the commission may make of their former employers and others acquainted with their experience and qualifications. The duties of this position are that of research assistant in the chemical department of the Psychiatric Institute, and candidates should be able to furnish undisputed evidence of some experience in work in the chemistry of the brain in connection with a research laboratory under the direction of a recognized authority among physiological chemists.

The *Plant World* announces two prizes which are to be awarded for the best papers embodying original work in any phase of the water relations of plants. The amount of the first prize is $50, and of the second prize $10. The offering of these purses is made possible by the generosity of Professor B. E. Livingston and by contributions from Dr. D. T. MacDougal, Professor J. J. Thornber, Dr. J. B. Overton, Dr. H. C. Cowles and Mrs. Edith B. Shreve. Competing papers should be written so as to give no internal evidence of authorship, and should be sent to the editor of the *Plant World* by December 1. The *Plant World* reserves the right to publish any papers submitted in the contest.

Dr. Stephen Smith recently received the following resolutions which were passed at the last meeting of the American Public Health Association, held at Jacksonville, Fla., in December:

Resolved, That the American Public Health Association desires to extend to Dr. Stephen Smith,

one of the first organizers of this association in 1872, its congratulations on his continued enjoyment of health and its joy and pleasure in being able to illustrate the outcome of his efforts and those of his colleagues in the present prosperity of the association, which has expanded until it represents the public health interests of four countries and of one hundred and twenty-five million people.

Resolved, That the association wishes Dr. Stephen Smith all of the happiness which the contemplation of a life spent in public service for the amelioration of the sufferings of mankind may bring.

THE St. Lawrence River system is international, and new questions arise almost every year with respect to the proper division of authority over and the use of this great source of water supply. An important report, recently issued by the United States Geological Survey, entitled "Surface Water Supply of St. Lawrence River Basin, 1913" (Water-Supply Paper 354), by C. C. Covert and W. G. Hoyt, contains results of steam-flow measurements made in the St. Lawrence River basin during the year 1913. The report includes measurements on rivers emptying into the St. Lawrence by way of Lake Champlain and the Richelieu in New York and Vermont. The diversion of water for the development of power at Niagara has recently claimed the attention of both the countries interested, and another question quite as important now is that of the propriety of permitting the city of Chicago to divert large volumes of water from Lake Michigan through its drainage canal into Illinois River. By reason of the prospective decrease in the depth of navigable waterways, especially those between Lakes Michigan and Huron, and between Lakes Huron and Erie, protests have been made by the Canadian authorities. The two questions mentioned illustrate the importance of determining accurately the amount of water supplied to the Great Lakes and St. Lawrence system by the tributaries within the United States, because international questions may at any time arise in settling which data of this kind may be of the utmost importance. Water-Supply Paper 354 is the latest of a series of similar annual volumes covering measurements on the principal streams of the St. Lawrence basin. The work done in Minnesota, New York and Vermont was in cooperation with the state authorities. A copy of the report may be obtained on application to the Director of the U. S. Geological Survey, Washington, D. C.

COLUMBIA UNIVERSITY has appointed the following non-resident lecturers for the 1915–16 session of the graduate course in highway engineering: Charles J. Bennett, state highway commissioner of Connecticut; John A. Bensel, consulting engineer; Will P. Blair, secretary, National Paving Brick Manufacturers' Association; Sumner R. Church, manager, research department, Barrett Manufacturing Company; Frederick A. Cleveland, director, Bureau of Municipal Research, New York; William H. Connell, chief, bureau of highways and street cleaning, Philadelphia; Morris Llewellyn Cooke, director, department of public works, Philadelphia; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey; Charles Henry Davis, president, National Highways Association; A. W. Dow, chemical and consulting paving engineer; Edwin Duffey, commissioner of highways, New York state; Lewis R. Ferguson, assistant secretary, Association of American Portland Cement Manufacturers; C. N. Forrest, chief chemist, the Barber Asphalt Paving Company; Wilson P. Foss, president, the New York Trap Rock Company; Walter H. Fulweiler, chief chemist, the United Gas Improvement Company; E. P. Goodrich, consulting engineer; D. L. Hough, president, the Cuban Engineering and Contracting Company; William A. Howell, engineer of streets and highways, Newark; Nelson P. Lewis, chief engineer, board of estimate and apportionment, New York; Walter R. Marden, vice-president and chief engineer, the United Construction Company; H. B. Pullar, general manager, the Pioneer Asphalt Company; Philip P. Sharples, manager, General Tarvia department, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemical engineer; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, New York; John Cassan Wait, attorney at law;

George C. Warren, president, Warren Brothers Company.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Luther Dana Waterman, of Indianapolis, professor emeritus in the Indiana University School of Medicine, has made a gift to Indiana University amounting to one hundred thousand dollars, subject to an annuity during his life time on the condition that the university appropriate an amount equal to the income from this gift, the entire proceeds to be used for scientific research. The conditions and gift have been accepted by the trustees of the university.

Albert Bonnheim, of Sacramento, has given to the University of California an endowment of $30,000 with provision for its subsequent increase to $160,000, the income to be devoted to the maintenance of scholarships.

Another gift of $85,000 has been made for the erection of dormitories at Cornell University. This gift comes from the same anonymous contributor of $250,000 some time ago. Two dormitories under construction are expected to be ready for occupation by September 1.

Dr. Henry Albert Mattill, who recently resigned his chair in the University of Utah, has been appointed assistant professor of nutrition in the University of California.

J. Brownlee Davidson, of Iowa Agricultural College, has been called to the University of California to fill a newly established professorship of agricultural engineering. His special work is to be to develop at the University Farm at Davis a testing plant for investigation of the fundamental reasons for efficiency of farm machinery.

Howard Spencer Reed, now professor of plant pathology and bacteriology in the Virginia Polytechnic Institute, has been appointed professor of plant physiology in the Citrus Experiment Station and Graduate School of Tropical Agriculture, recently established by the University of California at Riverside, California.

The following appointments and promotions in the Stanford University Medical School have been made for the year 1915–16: Dr. Charles Harvey Bailey, formerly connected with the Crocker Research Laboratory, New York City, has been made assistant professor of pathology. Dr. Henry Augustus Stephenson, formerly assistant in obstetrics and gynecology in the Johns Hopkins Medical School, has been made assistant professor of obstetrics and gynecology. Dr. George De Forest Barnett (M.D., Stanford, '13) and Dr. Jean Redman Oliver (M.D., Stanford, '14) have been made instructor in medicine and instructor in pathology, respectively.

The following appointments were made at the last meeting of the executive committee of the Massachusetts Institute of Technology, the resignations of E. H. Magoon, assistant in civil engineering and Thomas Buel, research assistant in electrical engineering, being accepted. Dr. Barnum B. Libby and George Rutledge, instructors in mathematics; Clark S. Robinson and Clifton N. Jacobs, instructors in inorganic chemistry; Francis C. Atwood and Roscoe G. Dickinson, assistants in theoretical chemistry; John N. Dalton, assistant in organic chemistry; Charles H. Rosenthal, Robert V. Townsend and Donald A. White, research assistants in applied chemistry, and R. J. Wiseman and Albert C. Brown, research assistants in electrical engineering.

Dr. Cornelius Betten has resigned the professorship of biology in Lake Forest College to become secretary of the College of Agriculture in Cornell University.

Howard B. Lewis, Ph.D., instructor in physiological chemistry at the University of Pennsylvania, has been appointed an associate professor in the University of Illinois.

Messrs. F. T. Brooks, Emmanuel College, and R. H. Compton, Gonville and Caius College, have been appointed demonstrators of botany at Cambridge.

Dr. J. Sholto C. Douglas, lecturer on pathology in the University of Manchester, has been appointed to the Joseph Hunter chair of pathology in the University of Sheffield in succession to Professor Dean.

DISCUSSION AND CORRESPONDENCE

BIRD COLLECTING AND ORNITHOLOGY

THE letter from Mr. Joseph Grinnell published in SCIENCE for February 12 last, in which he pleads for the conservation of the old-fashioned bird collector has led the present writer to suggest a few points on the other side of the question. The menace to our laws protecting birds and to our system of government bird reservations contained in Mr. Grinnell's attacks on them does not seem serious, nor does anything in his letter appear likely to greatly affect the opinion now prevailing not only among the general public, but among scientific men, that even a much more complete disappearance of such bird collectors can be contemplated without anxiety for the future of science in general and of ornithology in particular; that the usefulness of such collectors except in remote and little explored regions has largely gone by; that their assistance to real science is rarely more than very slight and oftener nothing at all; and that their destructiveness is very great. Too many of Mr. Grinnell's claims are directly opposed by the results of practical experience. For instance, who can deny that many holders of permits for collecting birds for scientific purposes are using them for commercial collecting, and that many of those who are making bird collections either with or without such permits encourage violations of the law by others through buying specimens from those who have no right to kill or sell them? Yet Mr. Grinnell would have us break down all restrictions, and have collecting permits "issued by both state and federal governments freely to applicants upon avowed sincerity of purpose."

Neither does Mr. Grinnell's claim that sportsmen are more liberally treated than those claiming to have scientific purposes in view require discussion here. The rapid decrease of our game birds indicates the need of better control of the sportsmen, but not necessarily the removal of restrictions from others.

On the other hand, there are many questions raised in or suggested by this letter that are timely and deserve serious consideration, and it is to some of these that the writer intends to confine his communication. Are any real scientific investigations, even of very minor importance and doubtful value, being prevented or hindered by existing restrictions on collecting? If so, can Mr. Grinnell name them? Has not systematic ornithology, that is the distinguishing and describing of new species, subspecies and races, proceeded to such a point in nearly all parts of North America that material is now needed as a basis for any reliable conclusions in amount far beyond what even the most capable amateur can accumulate, even if unrestricted in his collecting? Are not the large collections of the National Museum and other public and semi-public institutions made partly for just that kind of study, and is not the help of such institutions liberally given to those who desire it?

The writer will not maintain that there are not still many restricted and special problems in systematic ornithology even in the United States, which independent study can effectively deal with. Is there any would-be investigator having a definite problem of that kind to settle that finds his purpose blocked by the refusal to permit him to collect the limited and special material necessary for his needs?

The scientific value of the average bird collection, or even of one made with far more than average care, is greatly overrated. As a rule the collector publishes little or nothing in regard to his studies, if indeed he does study his specimens at all. If he happens to be a wealthy man he may acquire large series of birds and eggs, entailing great destruction of bird life and disastrous effects on some of our rare and disappearing species; but when he tires of his fad, or when his collection comes into the possession of his heirs, it is not unlikely to perish from dust, moths and careless keeping, or, if eventually donated or sold to some public or educational institution, to reach the latter in a condition where most of its scientific value has been lost. Amateur collectors frequently fail to preserve those notes and data by which they might fill the gaps in our scientific knowledge and the deficiencies in the descriptions in our scientific

books, because they do not know enough to do so, or are too careless or too hurried in their endeavors to get large series of specimens. The source, localities and dates of the specimens in such collections are often doubtful, since the collectors are likely to be careless in distinguishing between reliable first-hand information and that which somebody tells them, and too ready to accept as truth and to record as facts statements of unscrupulous dealers in regard to the specimens they sell; and the existence of material scattered in small collections is generally unknown to those who might employ it to advantage in the investigations they are conducting. The number, cheapness and general accessibility of reliable books on birds, many of them with photographs from life and colored illustrations of a high degree of accuracy, has greatly detracted from the educational importance of bird collections, not only for the general public, but for those wishing more than a superficial acquaintance with our birds.

If annoying restrictions are in some places imposed on scientific ornithologists, is it not largely because they have too often allied themselves with those who collect birds and eggs merely as a hobby, and who might better be engaged in the less destructive pursuit of collecting postage stamps? No doubt this alliance has been partly for the sake of increased opportunities for obtaining specimens by purchase or exchange, and partly because of a belief that some ornithological genius might develop among the amateurs thus incited to greater efforts. But has not the actual result been to lower the character of bird study—to place ornithology in a position apart from other branches of zoology and nearer to pursuits not truly scientific?

It has resulted in spreading altogether mistaken ideas of what science is and of what ornithology should be, and encouraged such false and destructive delusions as the common idea that one of the highest achievements of the ornithologist is to kill some rare straggler or accidental visitor and "establish a record" or "add to the fauna" of his state or county some species not previously listed, which, from any common sense point of view does not properly belong to the fauna at all. If such rare bird visitors are of species formerly found in the region but now practically or entirely exterminated, their killing may effectually put an end to an attempt to reoccupy the abandoned territory, and thus prevent the species being added to the fauna in reality, not merely in ornithologist's language. The writer thinks that many ornithologists and other scientific men who believed in their younger days that it was a necessary incident, if not the largest element, in being an ornithologist, to go out and shoot catbirds, scarlet tanagers and bluebirds, and rob their nests, have now discovered that they did so because they did not know any better, or followed bad advice given by other collectors or contained in the older manuals for ornithologists. Most of them will certainly be inclined to suspect that they could have learned many times as much about birds in less destructive ways, and probably few of them would in that case have found bird study any less interesting. More is being discovered about birds to-day with field glasses and cameras than with gunpowder and shot, and much of it is trustworthy scientific information, which to say the least ranks as high in interest and value to humanity as that which the average bird collector's cabinet of bird skins and egg shells can afford.

In closing the writer would like to emphasize the fact that this is no time for reactionary protests and attacks on the tardy and insufficient efforts that are at last being made to save our native birds and animals from extinction. The indifference displayed by scientific men to the destruction that has been and is still being carried out in every part of the world is far from creditable, since in many cases they are the only ones who realize its extent and inevitable results, and who can bring the subject to the attention of the public and intelligently plan and direct methods to stop it. The list of North American birds already destined to extinction within the next few years is considerable. Only very prompt action will save a good many others whose preservation is not yet hopeless.

The large whales and certain other marine mammals, a considerable proportion of the

larger land mammals of the world, and the peculiar and interesting indigenous faunas of many small islands may still be permanently preserved by prompt protective measures, and not merely state and national action, but as soon as the war is over, international agreements to bring about cooperation for these ends are urgently needed. Future generations will look back on the present time as an age of shameful vandalism as far as nature is concerned. Our present imperfect and feebly carried out efforts for the preservation of the most interesting and wonderful of the birds and mammals that still survive are insufficient. They must be on a larger scale and more effectively and intelligently conducted than at present. It should be the effort of every scientific man, and especially of the larger and more influential scientific associations, to bring the seriousness of the situation to public notice and to insist on prompt action. This is vastly more important for zoology to-day than the naming of new subspecies or than disputes over the validity of scientific names, and should put an end to complaints over small personal and temporary inconveniences which regulations of the greatest importance may incidentally occasion.

WILLARD G. VAN NAME
NEW YORK STATE MUSEUM

FUNDAMENTAL EQUATIONS OF MECHANICS

TO THE EDITOR OF SCIENCE: We are greatly interested in the contribution to the teaching of elementary dynamics made by Professor Kent in his letter to SCIENCE appearing in the issue of March 19, in which he presents as the fundamental equation of mechanics $V=FTg/W$, where F, T and W are, respectively, force in pounds, time in seconds and quantity of matter in pounds, g a numerical factor of proportionality and V velocity in feet per second. This equation has the great advantage of avoiding the extremely awkward necessity involved in apparently simpler formulations of the experimental laws under consideration, of defining force in terms of mass, as so many of the more conservative physicists insist on doing, or of defining mass in terms of force, a thing which many of these conservative physicists seem to consider as the only alternative and which all engineering writers appear to disclaim with equal vehemence.

There can be no doubt of the difficulty of measuring quantity of matter, that is comparing the quantities of matter in two bodies, one of which is taken to be a standard, except by resorting to forces acting upon them. On the other hand, there can be no doubt of the inadvisability of attempting to preserve an international prototype force instead of a prototype quantity of matter, owing to the probability that secular changes in the elastic properties of material bodies would be vastly greater than changes in their quantity of matter. To be sure it would be possible to define the international prototype force in terms of the gravitational relation of a given body to the earth, but this would be open to the same objection as the one that was raised in regard to measuring the quantity of matter in a body by resorting to forces. We therefore think that Professor Kent has done well to retain force and quantity of matter as equally fundamental.

What seems to us as unfortunate is the necessity of defining velocity in terms of distance and time. Why not regard all dynamical quantities that are sufficiently distinct to be given different names as equally fundamental? Why stop with distance, time, quantity of matter and force? We see no reason for imposing on ourselves such a limitation.

On this principle the equation $F=ma$, to which Professor Kent objects because it is not true unless we make m an arbitrary symbol for W/g, is open also to our objection that a has been defined in terms of other magnitudes, whereas nature has furnished us with a definite acceleration, that of a body under the influence only of its gravitational relation to the earth at sea-level and latitude 45° as modified by its tendency to rise due to the rotational motion, which may well be taken as unit acceleration.

It appears to us that Professor Kent's contention is essentially this: that since the *concept* of force is independent of quantity of matter, distance and time, it is irrational to force people to take their *measure* of force from a dynamical equation involving these three sorts of magnitudes. We should take

our measure of force from some phenomenon more closely related to the concept. What we are conscious of when we lift a pound weight is not the amount of matter in it, but the force upon it.

If this sound reasoning is to be applied to all the concepts of mechanics it will be necessary to modify most of the equations slightly by introducing a proportionality factor. This has already been suggested by Professor Hoskins in a footnote to his review of Maurer's "Technical Mechanics," [1] but he failed to make the most of his opportunity. We present here a tentative scheme only and the calculated values of a few of the constants. Our choice of fundamental units of velocity and acceleration are, we freely admit, open to the criticism of being ill-considered and off-hand. Still they will do perfectly well to illustrate the method, and certainly they are much better than the units in common use which only tend to cloud the physical entity and reality of the magnitude in question by reference to others more or less closely related. Who that has considered with any care his sensations of a passing express train does not realize that his impressions on the subject "how fast" are much more direct and elemental than any question of "how far" or "for how long"?

We begin then with the units of force, distance, time, quantity of matter and acceleration as defined above and which for our present purpose may be regarded as sufficiently unrelated to be called independent, fundamental units. What definite velocity does nature present to us that we may take as unity? After considering the peripheral and the orbital velocity of the earth and the maximum attainable velocity due to terrestrial gravitation (that of a body falling from the hypothetical "infinite distance"), it seemed well to abandon such gravitational velocities as being dangerously near to our definition of unit force (a totally unrelated concept) and adopt the velocity of light, which is one of the most definite and unalterable things in nature. This unit we call the "speedal," not from any wish to be bizarre, but merely because some name is necessary to show where the idea leads us. 10^{-6} speedals we will call a micro-speedal. We see no real objection to calling it pounds, since we already employ this useful word to designate unit quantity of matter and unit force, but perhaps the present name will serve our purpose better.

Let W = quantity of matter in pounds,
S = distance in feet,
T = time in seconds,
F = force in pounds.

(Whether these are the same pounds as mentioned above or other pounds seems to be of no importance.)

V = velocity in micro-speedals,
A = acceleration in "gravitals,"

and α, β, γ, δ, etc., be numerical constants of proportionality. We may write the following equations:

$$V = \alpha S/T, \tag{1}$$

$$A = \beta V/T = \alpha\beta S/2T^2 = \gamma S/T^2, \tag{2}$$

where it is understood that V in equation (2) is a *change* in velocity and therefore twice the *average* velocity defined by (1). (Initial velocity being zero.)

$$F = \delta WA = \beta\delta WV/T = \gamma\delta WS/T^2. \tag{3}$$

From these three fundamental equations we may derive equations such as

$$FT = \gamma\delta WS/T = (\gamma\delta/\alpha)WV = \epsilon WV \tag{4}$$

and

$$FS = \gamma\delta WS^2/T^2 = \gamma\delta WV^2 = \zeta WV^2. \tag{5}$$

And from these, as soon as we have established units for momentum M, energy E, impulse I and work Z, and determined the constants in equations like $I = \eta FT$ and $M = \theta WV$, we could derive the equations of momentum and of energy.

The values of the constants may be easily computed. Since one micro-speedal is 1,182.9 feet per second, $\alpha = 1{,}182.9$. The equation for an acceleration of one foot per second per second is

$$\frac{1}{32.1740}A = \frac{1}{1182.9}\frac{V}{T},$$

which gives us at once

$$\beta = \frac{32.1740}{1182.9} = .027200.$$

[1] Science, December 4, 1914.

Also $\gamma = \alpha\beta/2 = 16.0870$. The coefficient δ is unity, which is a little unfortunate since it might lead to the erroneous impression that we were *defining* unit force as that force which gives unit acceleration to unit mass. Our choice of unit acceleration has probably been injudicious.

Enough has been given to illustrate the principle which we feel sure ought to commend itself to every one who once grasps the fundamental independence of all dynamical concepts and the strictly proportional nature of the dynamical equations, all of which are merely the algebraic formulation of experimental evidence. In extenuation of our introduction of a new set of numerical constants to be memorized we can only point out that there were many "$\frac{1}{2}$'s" "4π's," etc., there already and that we entirely do away with the troublesome and useless subject of dimensions.

The new system is not fully developed as yet, however, and until it is we have found ourselves compelled to make the best of the old one. We dodge the ambiguity in the "ambiguous words 'weight' and 'mass'" by the artifice of defining them. We adopt and we teach the convention that "mass" shall be an exact equivalent for "quantity of matter," and that "weight" means the gravitational *force* upon a mass. We teach that the *measure* of a force (wherever the *concept* of force may originate) may conveniently be defined by the equation $F = ma$. We teach that it is a remarkable law of nature, determined only by experiment, and not to be suspected *a priori*, that the "body factor" in this equation is strictly proportional to the weight for all bodies in the same uniform gravitational field. We point out that pounds-mass and pounds-weight (*i. e.*, pounds-force) are totally different things, and that there are 32.2– of the units of force defined by the equation $F = ma$ in a pound-weight and that therefore all forces deduced in dynamical equations must be divided by 32.2 if we wish to express them in terms of pounds-weight, much as one would reduce centimeters to feet. Conversely, all forces given in pounds-weight must be multiplied by 32.2 before they can be used in dynamical equations. We teach that the fundamental idea of the gravitational constant g is force per unit mass and that it is also of the nature of an acceleration in virtue of the relation $F/m = a$. We hold that dynamics *may* be developed without the introduction of arbitrary constants by the assumption of three fundamental units and defining all the others in terms of these three. We object to Professor Kent's description of a system with four fundamental units as a "foot-pound-second" system instead of a "foot-pound-second-pound" system, and to his ridicule of the "gee-pound" or "slug" in the same letter in which he says, "It has been found convenient to use the letter m instead of W/g." What is the *unit* of m if not the "slug"? We frankly talk about a unit of force called a poundal as a matter of convenience, and we measure it by a defining equation much as we measure a unit of velocity or of work. We consider this term preferable to the "pound-foot-per-second-square," and venture to hope that there may some day be introduced shorter names for the "foot-per-second-per-second" of acceleration and the "pound-foot-square" of moment of inertia.

T. L. PORTER,
R. C. GOWDY

THE UNIVERSITY OF CINCINNATI

ANOTHER STATE PARK NEEDED

TO THE EDITOR OF SCIENCE: Two or three notes of interest have appeared in SCIENCE regarding the new state reservation at Jamesville, Onondaga County, New York, which includes the glacial lake, sometimes known as West Green Lake. This little lake is of especial interest owing to its history as the site of the plunge basin of a great glacial waterfall, and also because in its environs is found the hart's tongue fern (*Phyllitis Scolopendrium*) which probably ranks as the most interesting and rarest fern in the United States.

Now it is proposed to acquire another lake of identical geological history, East Green Lake (also known as Blue Pond, and *Scolopendrium* Pond), which lies about a mile east of the west lake above mentioned. The pro-

posal was first made in the correspondence columns of a Syracuse paper, the *Post-Standard,* and has since been taken up by local people until there is considerable possibility of its ultimate success. A committee of representative business men has been appointed to further the project.

The matter is here brought to the attention of readers of Science in order to ask that any who can help may be moved to use their influence with state officials or any others who might render help. East Green Lake and the surrounding region represent a larger and wilder tract of land. The lake itself is of equal geological interest and from the standpoint of the hart's tongue fern, is of greater interest than the west lake region because the best specimens in the country grow near the east lake. The west lake preserve includes only seventy acres, as this was all that was of special value as park. In the east lake region it is proposed to acquire two square miles to include not only the lake plunge-basin itself but also a marl-bottomed lake nearby and additional acres of beautiful woodland.

The preservation of the best stations for the hart's tongue fern, probably the rarest and most interesting fern in North America, is sufficient reason for urging the acquirement of this proposed new park. Besides this species there are other ferns to the number of about forty, making it probably the best fern preserve in the country. The need of prompt action is indicated by the fact that a lime development company now holds an option on the tract desired.

R. C. Benedict

SCIENTIFIC BOOKS

Theory of Measurements. By James S. Stevens, Professor of Physics in the University of Maine. New York, D. Van Nostrand Company. 1915. Pp. vii + 81. Price $1.25 net.

This little book is intended to fill the gap between the fragmentary treatment of the errors and adjustment of measurements, found in most laboratory manuals, and the detailed discussions given in formal treatises on the theory and precision of measurements. In eight short chapters, the author deals with the following topics: Measurements and Errors; Probability, including a discussion of the probability curve and integral; Adjustment of Observations; Precision of Measurements; Propagation of Errors, applied to direct and inverse problems; Plotting; Negligibility, including rules for the use of significant figures; Empirical Formulæ and Constants.

The methods and notation adopted are similar to those employed in Merriman's "Method of Least Squares" and Holman's "Precision of Measurements." The treatment is necessarily abridged to comply with the limits set by the scope of the book but the usual formulæ and methods are developed in sufficient fullness for their practical application by the intelligent student. Possibly owing to his desire to save space, the author gives very little discussion or explanation of the fundamental principles and assumptions underlying his mathematical derivations. Consequently the true significance of his results is not always apparent and the conditions essential for their correct application are apt to be overlooked. For example, the deductions from the law of accidental errors do not apply to a series of observations affected by systematic errors but the author has nowhere pointed out the necessity of considering such errors in connection with the discussion of precision.

Definitions and problems are frequently so briefly and inadequately stated that the unaided student is apt to misinterpret their meaning. The following quotation is a fair example: "Measurements are usually classified as follows: 1. *Direct*—when, for example, a distance is measured with a tape line. 2. *Indirect*—when the density of a cylinder is determined by measurements of its length, diameter and mass. 3. *Conditioned*—when the third angle of a triangle is restricted by the values of the other two angles. Measurements not so conditioned are called *independent.*"

However, with the aid of a competent teacher, the student should be able to make profitable use of the book in connection with

his work in the physical laboratory and acquire some facility in determining the accuracy and significance of his measurements.

A. DE FOREST PALMER

Electric Arcs. By CLEMENT D. CHILD, Ph.D., professor of physics, Colgate University. New York, D. Van Nostrand Company. 1913. Pp. 194.

A text of this kind must interest at least two classes of readers; those who wish to know more of the physics of the electric arc and those who are intensively engaged in arc lamp development. The author has digested the results of those investigations made since the publication of Mrs. Ayrton's "The Electric Arc," which contains a similar digest of the investigations made previous to 1898.

In the first six chapters the author discusses the relations between terminal voltage, current, resistance and E.M.F. of pure carbon, impregnated carbon, pure metal and metallic oxide arcs operated with direct and alternating current in air and in various gases at different pressures. This discussion also includes the performance of the mercury arc rectifier and the mercury arc lamp under various conditions.

The seventh chapter, headed "Photometry of the Electric Arc," contains information regarding the light-producing properties of various electric arcs and scarcely touches upon the measurement of light suggested by the caption. The following chapter contains a brief review of the use of the electric arc in wireless telephony. All hypothesis regarding the electric arc is reserved for the last chapter, where the author offers an explanation of certain arc phenomena in the ionic theory.

The book would take on added interest from the scientific viewpoint if it contained references to the action of electric arcs between metal terminals in liquids such as alcohol, mineral oil, carbon-tetrachloride, etc., or high tension arcs in air. Although the book title suggests a more general discussion the author pays more attention to the "light-producing electric arc."

The text includes an extensive bibliography to which detailed references are made at the appropriate place. The continuity of the discussion is increased by the results of the author's own investigations whenever the reports of others failed to reveal the required data. Thoroughness and presentation of many viewpoints characterize the text throughout. To the student interested in electric arc phenomena a careful reading of Mrs. Ayrton's text followed by that of Dr. Child should prove an invaluable foundation upon which to base further investigations.

R. G. HUDSON
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SCIENTIFIC JOURNALS AND ARTICLES

THE April number (Vol. 16, No. 2) of the *Transactions of the American Mathematical Society* contains the following papers:

L. E. Dickson: "Quartic curves modulo 2."

W. A. Hurwitz: "Mixed linear integral equations of the first order."

W. B. Fite: "Prime power groups in which every commutator of prime order is invariant."

W. A. Manning: "On the order of primitive groups, II."

J. W. Alexander, II.: "A proof of the invariance of certain constants of analysis situs."

A. B. Coble: "Point sets and allied Cremona groups (part I.)."

C. T. Sullivan: "Scroll directrix curves."

THE April number (Vol. 21, No. 7) of the *Bulletin of the American Mathematical Society* contains: "The rôle of the point-set theory in geometry and dynamics," by E. B. Van Vleck; "An enumeration of integral algebraic polynomials," by A. B. Frizell; "Mr. Paaswell's appeal to producing mathematicians," by C. N. Haskins; Review of Volterra's Leçons sur les Fonctions des Lignes, by G. A. Bliss; "Shorter Notices": Lehmer's List of Prime Numbers from 1 to 10,006,721, by L. E. Dickson; Whitford's The Pell Equation, by T. M. Putnam; Liebmann and Engel's Die Berührungstransformationen: Geschichte und Invariantentheorie, by T. H. Gronwall; Pasch's Veränderliche

und Funktion and Voss's Ueber das Wesen der Mathematik, by R. D. Carmichael; M'Lachlan's Practical Mathematics, by T. E. Mason; Klein's Elementarmathematik vom höheren Standpunkte aus, Teil II., Netto's Elementare Algebra, Gans's Einführung in die Vektoranalysis mit Anwendungen auf die mathematische Physik, and Rothe's Darstellende Geometrie des Geländes, by T. H. Gronwall; Borel's Le Hasard, Ingersoll and Zobel's Introduction to the Mathematical Theory of Heat Conduction, and Duhem's Le Système du Monde, Tome I., by R. D. Carmichael; Lecornu's Cours de Mécanique, Tome I. and Guichard's Problèmes de Mécanique et Cours de Cinématique, by W. R. Longley; "Notes," and "New Publications."

The May number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole; "The Legendre condition for a minimum of a double integral with an isoperimetric condition," by C. A. Fischer; "Note on the derivative and the variation of a function depending on all the values of another function," by G. C. Evans; Review of Sommerville's Elements of Non-Euclidean Geometry, by J. L. Coolidge; Review of Minkowski's Collected Works, by E. B. Wilson; "Shorter Notices": Bioche's Histoire des Mathématiques, by D. E. Smith; Richardson's Solid Geometry, by R. B. Robbins; Hall's Geometrical Vector Algebra, by F. L. Hitchcock; Prescott's Mechanics of Particles and Rigid Bodies, by W. R. Longley; Annuaire pour l'An 1915, publié par le Bureau des Longitudes, by E. W. Brown; "Notes"; and "New Publications."

The June number of the *Bulletin* contains: Report of the April meeting of the society at Chicago, by H. E. Slaught; "A geometric derivation of a general formula for the southerly deviation of freely falling bodies," by W. H. Roever; "Note on solvable quintics," by F. N. Cole; Review of the Madison Colloquim Lectures on Mathematics, Part I., by O. E. Glenn; "Some books on calculus" (Granville, Snyder and Hutchinson, Davis, Vivanti), by E. B. Wilson; "Notes," and "New Publications."

SCIENTIFIC RESULTS OF THE TERRA NOVA EXPEDITION

The British Museum has undertaken the publication of the Natural History results of the British Antarctic Expedition of 1910, better known as the Terra Nova Expedition. These results will be issued in parts as fast as they are prepared. The first part to be printed is a description of the fossil plants by Professor A. C. Seward of Cambridge.[1]

An especial interest attaches to the small collection of geological specimens that were retrieved after the tragic death of Captain Scott and his heroic associates, and the present publication bears ample testimony to the fact that their efforts have not only furnished the world with a lasting monument to British pluck and manhood but have also yielded facts of the greatest scientific interest.

Although determinable fossil plants are few in number traces were seen, as well as numerous carbonaceous laminæ and small seams of coal, at a number of widely separated localities, particularly in what is called the Beacon sandstone, which at latitude 85° S. is 1,500 feet thick. This comprises an upper 500 feet of sandstone resting on 300 feet of interbedded sandstone and shale with several seams of coal, underlain by 700 feet of similar sandstone conglomeratic at the base. The character of the grains in the sandstone suggests wind action, and sun cracks and ripple marks have also been observed. This extensive formation has been traced from Mt. Nansen as far south as latitude 85°, a distance of over 700 miles.

The most significant plants are those representing the genus *Glossopteris* found at Mount Buckley or Buckley Island which is situated just west of the Beardmore Glacier in latitude 85°. These are partly referred to the widespread *Glossopteris indica* Schimper and in part described as a new variety of that species. There are also represented objects identified as those of *Vertebraria* and representing the axial organs of *Glossopteris*, and others doubt-

[1] Seward, A. C., "Antarctic Fossil Plants," British Museum (Natural History) British Antarctic (Terra Nova) Expedition, 1910. Natural History Report. Geology, Vol. 1, No. 1, pp. 1–49, tf. 1–6, maps A–C, pls. 1–8, 1914.

fully correlated with the scale leaves of the latter genus. From the Priestley Glacier rather indifferently preserved wood is described under the name *Antarcticoxylon Priestleyi* and considered as a new type probably Araucarian in its relationship. Winged pollen grains are described as *Pityosporites antarcticus*. These are suggestive of the Abietineæ, but may be those of the Podocarpineæ. The remainder of the collection has little interest beyond its indication of the presence of arboreal forms in high southern latitudes.

The exact age of these plant-containing beds can not be definitely determined from the present collections, although there is no reason to doubt the legitimacy of the author's conclusion that the Beacon sandstone is probably Permo-Carboniferous in age with the further possibility that its upper part may be early Mesozoic.

The demonstration of the former presence of *Glossopteris* in Antarctica is of the greatest importance. It may be recalled that during the late Devonian or early Carboniferous a flora that may be called a cosmopolitan flora, characterized by such genera as *Bothrodendron, Archæocalamites, Archæopteris,* etc., has been found in Ellesmere Land, Spitzbergen, Greenland, Europe, North and South America, South Africa and Australia. Late in the Upper Carboniferous the floras of the world may be segregated into a northern province, of the cosmopolitan type and a southern province characterized by the *Glossopteris* flora as Neumayr termed it or the *Gangamopteris* flora as christened by David White. This latter flora, associated with glacial climatic conditions, has now been recognized from Australia, Tasmania, India, Madagascar, South Africa and South America. Its presence in Antarctica supplies an important link in the chain connecting the now isolated land masses of the southern hemisphere and also suggests the possibility of this flora having originated on the broad bosom of the Antarctic continent.

An elaboration of this theme would be out of place in the present notice. It has been somewhat fully discussed by Professor Seward in the present connection and it was also fully discussed by David White[2] in 1907 in connection with his study of the flora of the coal measures of Brazil. Arber's general account[3] of the *Glossopteris* flora, which was reviewed by me[4] in these columns brought the subject down to about 1904. All of these works contain full bibliographic references to which the reader who desires to pursue the subject further is referred.

When the late Professor Heer published his first account of the Arctic fossil floras the greatest scientific interest was aroused. We have now come to see pretty clearly that existing climates may be regarded as the exception rather than the rule when geologic time is considered as a whole. This coupled with the already described accounts of Jurassic, Cretaceous and Tertiary plants from the Antarctic continent opposite from Victoria Land[5] tends to make the discoveries announced in Professor Seward's paper seem normal and just what we should have expected. This is, however, somewhat offset by the tragedy of the Scott expedition, and it should further be remembered that demonstration has now replaced speculation and we now have a groundwork of solid facts of great importance that promise much for the future.

EDWARD W. BERRY
JOHNS HOPKINS UNIVERSITY,
BALTIMORE

SPECIAL ARTICLES

A BOTANICAL INDEX OF CRETACEOUS AND TERTIARY CLIMATES

IN studying the distribution of Dicotyledons in the principal phytogeographical regions of the earth the writers have encountered certain

[2] White, David, "Permo-Carboniferous Climatic Changes in South America," *Jour. Geol.*, Vol. 15, pp. 615–655, 1907.

[3] Arber, E. A. N., "Catalogue of the Fossil Plants of the *Glossopteris* Flora in the Dept. of Geology, British Museum (Nat. Hist.)," London, 1905.

[4] Berry, E. W., SCIENCE, N. S., Vol. 23, pp. 780–782, 1906.

[5] Berry, E. W., "Some Paleontological Results of the Swedish South Polar Expedition under Nordenskiold," SCIENCE, N. S., Vol. 38, pp. 656–661, 1913.

interesting correlations between structural characters and climate. Particularly significant in the consideration of certain problems of geology and climatology is the climatic distribution of two types of leaves and leaflets. Those with entire margins predominate in tropical, arctic and alpine regions, moors, steppes, deserts, saline situations, and other physiologically dry environments. (In this connection it should be noted that the leaves of tropical rainforests and other tropical plant communities that live in moist environments, although often of relatively large size, are semi-xerophilous in structure.) Leaves and leaflets with non-entire margins, on the other hand, are comparatively infrequent in such situations, and are very numerous in moist temperate regions having cold winters and warm summers.

In the following table are given for a number of extensive regions in the frigid, temperate and tropical zones the percentage of entire-leaved woody plants in the Dicotyledonous flora.[1]

	Per Cent. Entire
Frigid	
Ellesmereland	100
New Zealand Alps	77
North East Siberia	65
Cold Temperate	
North East Germany	24
Central Russia	28
East Central North America	28
North Russia	30
England	32
Kamtschatka	33
Rocky Mountains	36
South East Siberia	37
West Siberia	44
France	44
Warm Temperature	
South Russia	39
East Central China	48
South East United States	49
Italy	50
Los Angeles Region	54
Spain	56
Sub-tropical and Tropical	
Hongkong	71
South West Asia	72
Bombay	72
Upper Nile Region	74
Southern Africa	74
Nicaragua	76
West Indies	76
Egypt	77
South East Central Africa	78
Brazil	79
Ceylon	80
Manila	81
West Central Africa	81
Queensland	82
New South Wales	82
West Australia	83
Florida	83
South West Central Africa	83
Mauritius-Seychelles	85
Malay States	86

[1] In the computation of the percentages given in this table woody Dicotyledons alone were used since herbaceous forms are of very infrequent occurrence in the fossil floras of the Cretaceous and early Tertiary.

In the temperate regions given above there are more or less extensive areas of physiologically dry environments which are reflected in the floras by plants with relatively small entire leaves. In the tropical regions, on the other hand, there are cool uplands and shady comparatively temperate habitats which possess many plants with non-entire leaves and leaflets. The effect of these cool uplands upon the character of the foliage is well illustrated by comparing the percentage of entire-leaved Dicotyledons in the mountainous Simla region (58 per cent.) with that of the adjacent Upper Gangetic Plain (71 per cent.), and also by contrasting lowland (76 per cent.) and upland (56 per cent.) Hawaii.

In view of these facts it seems desirable to give an analysis of two floras that are more nearly homogeneous phytogeographically. The first flora, cold-temperate mesophytic, was constructed by eliminating from the flora of east central North America (east of the 95th meridian and between the 40th and 50th parallels of latitude) all plants growing on physiologically dry environments. The second flora, tropical, was formed from the woody plants of the moist lowlands of the Amazon valley.

Mesophytic-cold-temperature

	Entire, Per Cent.	Non-entire, Per Cent.
Trees	10	90
Shrubs	14	86
Woody	13	87

Moist-lowland-tropical

	Entire, Per Cent.	Non-entire, Per Cent.
Trees	90	10
Shrubs	87	13
Woody	88	12

From this table it is clear that leaves with non-entire margins are of very infrequent occurrence in lowland tropical floras, and those with entire margins in mesophytic cold-temperate ones. In fact the correlation between leaf structure and climate is so intimate in widely separated regions of the earth and in the distribution of many families, genera and even species that the modifying influences of environment are clearly demonstrated. For more detailed evidence, in regard to correlations between foliar structures and climate and the probable function of the non-entire leaf margin, the reader is referred to the following papers.[2]

It has been stated above that in moist tropical regions the leaves are of comparatively large size (megaphyllous). Any large heterogeneous tropical region will contain in consequence, among its entire-leaved plants, varying proportions of megaphyllous and microphyllous types. Similarly, in sub-tropical and warm-temperate zones the entire leaves will consist of varying proportions of these two types, depending upon the distibution of rainfall and other factors. In cold-temperate regions, however, the entire-leaves will be composed almost entirely of comparatively small-leaved types.

The percentages of entire-leaved woody Dicotyledonous plants in a few Cretaceous and Tertiary floras are recorded in the next table.

Tertiary

	Entire, Per Cent.
Eocene-Green River-Lesq	29
Eocene-Arctic-Heer	29
Eocene-Spitzbergen-Heer	46
Eocene-Bad Lands-Lesq	29

Cretaceous

	Entire, Per Cent.
Montana-Knowlton	62
Patoot-Arctic-Heer	51
Atane-Arctic-Heer	81
Amboy-Newberry	67
Dakota-Lesq	54
Raritan-Berry	71

A comparison of the Tertiary percentages with those of modern floras indicates very clearly the general temperate character of the climates which prevailed in the regions where these fossil floras existed. Similarly, the percentages of non-entire leaves in the Patoot, Dakota and Amboy Cretaceous formations denote climatic conditions intermediate between those of tropical and temperate regions. The high percentages of entire-leaved forms (megaphyllous) in the Atane beds points to the tropical character of the climate which existed in certain arctic regions during parts of the Cretaceous.

Of course caution is needed in comparing any specific percentage in this table with that of a corresponding one in the table of living floras. This is due to the fact that one can not always be certain that any known fossil flora is a fair sample of the total ancient vegetation of which it once formed a part. Furthermore, the percentages of entire leaves in fossil and living floras must be homologous, that is, composed of similar portions of megaphyllous and microphyllous types.

In conclusion it should be noted that this method of studying fossil floras rests upon a physiological and ecological basis rather than upon the usual phylogenetic one. It promises to afford a simple and rapid means of gauging the general climatic conditions of the Creta-

[2] Sinnott, E. W., and Bailey, I. W., "Foliar Evidence as to the Ancestry and Early Climatic Environment of the Angiosperms," *Am. Jour. Bot.*, Vol. II., No. 1, January, 1915; Bailey, I. W., and Sinnott, E. W., "The Climatic Distribution and Physiological Significance of Certain Types of Angiosperm Leaf-margin." *Ined.*

ceous and Tertiary, and checking the accuracy of conclusions derived from other lines of evidence.

I. W. Bailey,
E. W. Sinnott

Bussey Institution,
Harvard University

THE BROWN GRAPE APHID

This aphid is commonly known as *Macrosiphum viticola* Thomas. Unable to find any record of its complete life cycle the writers have made some observations on the form at Vienna, Va. These seem worthy of note at the present time, in view of the economic importance of the species.

The eggs are polished black and are laid during November or late October. They are placed in the axils of the leaves of *Viburnum prunifolium* Linn. In the spring they hatch before the leaves open and the young feed on the bursting flower buds. The stem mother appears unlike a *Macrosiphum*, having short cornicles. Late in April, or in early May, the second generation matures and this nearly all becomes alate.

Such alate forms are unable to subsist on the *Viburnum*, but migrate to the grape and produce the third generation on that plant. Here the species lives throughout the summer, producing apterous and alate forms. We have also some intermediates similar to those recently described by us in *Aphis pomi* DeGeer. These intermediates were taken in May and June.

The fall migrants are unlike the spring migrants in sensory characters, the sensoria on the antennæ averaging about as follows: Segment III., 30; IV., 25; V., 15. These fall migrants may be found depositing their young upon the *Viburnum* leaves during the middle of October.

The ovipara is apterous and, after being fertilized by the alate male, deserts the leaves and migrates to the twigs in order to deposit her winter eggs.

A. C. Baker,
W. F. Turner

Laboratory Deciduous Fruit Insect Investigations, Bureau of Entomology, Vienna, Va.

THE RELATION OF MITOCHONDRIA TO GRANULES OF THE VITAL AZO DYES[1]

The more ardent hopes which relate to the subject of vital staining are perhaps connected with the successful staining of living, preformed components of the cell. Instances of such a phenomenon are often enough alleged without sufficient substantiation. Goldmann,[2] whose papers did so much to attract general interest to this subject, believed that the dyes, isamine blue and trypan blue, must be looked upon as combining with some preformed, but hitherto unidentified, elements of the living cell, and this is substantially the attitude of Kiyono,[3] who has added the latest considerable contribution to this subject. Tschaschin[4] of Maximow's laboratory has given this hypothesis its most concrete formulation by claiming that we are dealing with an elective, truly vital staining of the mitochondria of connective tissue cells. On the other hand, Evans and Schulemann[5] came to the conclusion that the process of staining with these dyes is more intelligible as an ultra-microscopic phagocytosis, and interpreted the dye granules as storage phenomena, in no way related to the living elements of the cell. In view of this discrepancy in the points of view of different workers, a cytological study of some of the cells which react to azo dyes has been suggested by Dr. Evans and carried out under his direction.

The study has been limited to cells of subcutaneous tissue in adult mice. As has been

[1] From the anatomical laboratory of the Johns Hopkins Medical School, Baltimore.

[2] Goldmann, E. E., "Die äussere und innere Sekretion des gesunden und kranken Organismus im Lichte der 'vitalen Färbung,'" Tübingen, 1909. "*Neue Untersuchungen usw.*," Tübingen, 1912.

[3] Kiyono, "Die vitale Karminspeicherung," Fischer, 1914.

[4] Tschaschin, S., *Folia Hæmatologica*, Bd. XIV., S. 295, 1912; Bd. XVI., S. 247, 1913, Bd. XVII., S. 317, 1913.

[5] Evans and Schulemann, *Jahresb. d. Sch. Ges. f. Vat. Kul.*, 1913; Science, Vol. XXXIV., p. 443, 1914; *Deut. med. Wochenschr.*, No. XIII., 1914.

described by Tschaschin, Evans and Schulemann, and others, the two common types of connective tissue cells are readily distinguished by their reaction to the vital stain, the clasmatocytes storing large masses, the fibroblasts much more minute granules of the dye. It can not be denied that the delicate punctate and rod-like deposits of isamine blue, as seen in fibroblasts, often make an astonishingly close approach to mitochondria in appearance. But are they mitochondria? This question could only be answered by applying to the cells in question the criteria for the recognition of mitochondria, which are well known to cytological technique. We have confined ourselves to three methods, which have been pursued until they yielded constant and reliable results. These are the iron hematoxylin method, the aniline acid-fuchsin methyl-green method (Bensley), and supra-vital staining with janus green (Michaelis, Laguesse, Bensley, Cowdry).

On studying in this way the fibroblasts of the mouse, mitochondria can easily be demonstrated. They disagree in several respects with the alleged isamine blue mitochondria. The true mitochondria are always scantier in number than the deposits of isamine blue which occur in fibroblasts of chronicly stained animals, and they are more definitely threadlike than the isamine blue structures. Further, it is quite possible to see the unstained mitochondria lying between the isamine blue granules in living cells, examined immediately after removal from the body, and finally, by staining with janus green, one can see these previously unstained structures now add themselves to the number of stained cytoplasmic elements, where their peculiarities as regards color, shape, size and arrangement are still retained. These conclusions obtain even more emphatically with trypan blue and presumably with all of the benzidene dyes.

In the vital staining with azo dyes, it is not true, consequently, as Tschaschin maintains, that we have a vital staining of the mitochondrial apparatus in some cells, in addition to the gross reception of the dye by the macrophages. Indeed, Tschaschin believes that in the macrophages themselves the mitochondria are stained vitally, but that here they are exclusively granular, spherical forms, and suffer all stages of transformation into the large "secretory" granules. The methods detailed for the study of fibroblasts yield essentially similar results when applied to the macrophages. These, in contradistinction to the claim of Tschaschin, have true mitochondria, some of them filiform, among the azo dye granules.

This discussion has wider implications, for Tschaschin's ideas have been accepted by Kiyono even though he recognizes some anomalous aspects of such a conclusion. Kiyono seems willing to believe that the macrophages may react to these dyes in a phagocytic or physical way but that this can not be the explanation for all the granules produced by these dyes, since the reception and storage of foreign substances by some of the other cells which are vitally stained is a phenomenon unknown by other methods. This argument seems beside the point. We can only state that in no case known to us have the granules produced by vital azo dyes been found to be identical with the mitochondria of the vitally stained cells.

KATHERINE J. SCOTT

THE AMERICAN PHILOSOPHICAL SOCIETY

THE annual general meeting of the American Philosophical Society was held in the rooms of the society in Philadelphia on April 22, 23 and 24. The meeting was opened on Thursday afternoon by President W. W. Keen, who, with Vice-presidents A. A. Michelson, W. B. Scott and Professor C. L. Doolittle, presided over the various sessions.

On Friday evening a reception was held in the hall of the Historical Society of Philadelphia, at which William Morris Davis, Sc.D., Ph.D., professor emeritus of geology, Harvard University, gave an illustrated lecture "On New Evidence for Darwin's Theory of Coral Reefs." The lecture described the chief results of a Shaler Memorial Voyage across the Pacific in 1914, with studies of the Fiji group, New Caledonia, the Loyalty Islands, the New Hebrides, the Great Barrier Reef of Australia and the Society Islands.

On Saturday afternoon a symposium was held on the Figure, Dimensions and Constitution of the Interior of the Earth. The subject was discussed

from the astronomical standpoint by Frank Schlesinger, Ph.D., director of Allegheny Observatory, Pittsburgh; from the geological standpoint by T. C. Chamberlin, Ph.D., LL.D., head of department of geology, University of Chicago; from the seismological standpoint by Harry Fielding Reid, Ph.D., professor of dynamical geology and geography, Johns Hopkins University, Baltimore; from the geophysical standpoint by John F. Hayford, director of college of engineering, Northwestern University, Evanston, Ill.

Fifteen new members were elected, the names of whom have been given in SCIENCE, Vol. XLI., page 640. The usual practise of electing foreign members was omitted this year.

The portrait of Dr. Edgar F. Smith, provost of the university and former president of the society, was presented by a donor whose name was withheld. The address of presentation was made by Vice-provost J. H. Penniman.

The meeting closed with a dinner at the Bellevue-Stratford, attended by about one hundred members and guests. The toasts were responded to as follows:

"The Memory of Franklin," by Hon. Simeon E. Baldwin.

"Our Universities," by Professor Harry Fielding Reid.

"Our Sister Societies," by Professor Ernest W. Brown.

"The American Philosophical Society," by Professor Marion D. Learned.

The following papers were presented during the various sessions of the society:

Devices for Facilitating the Analysis of Observations—More Particularly those of the Tides: ERNEST W. BROWN.

On Linear Integral Equations in General Analysis: ELIAKIM H. MOORE.

The paper opens with a brief account of the author's general theory of linear integral equations, a theory embracing by specialization the regular cases of various classical instances, and in closing it indicates a new general theory intended to embrace the most important irregular cases of the classical instances.

A Direct Solution of Fredholm's Equation with Analytic Kernel: PRESTON A. LAMBERT.

The Existence of a Sub-electron? ROBERT A. MILLIKAN.

The Work in Atmospheric Electricity aboard the "Carnegie": L. A. BAUER AND W. F. G. SWANN.

Local Disturbances in a Magnetic Field: FRANCIS E. NIPHER.

Explorations over the Surface of Telephonic Diaphragms Virbrating under Simple Impressed Sounds: A. E. KENNELLY AND H. O. TAYLOR.

The Hall and Corbino Effects: EDWIN PLIMPTON ADAMS.

The Hall effect is the production of a transverse difference of potential in a conducting sheet when an electric current flows through it and it is placed in a magnetic field perpendicular to its plane. The Corbino effect is the production of a circular current in a conducting disk when a radial current flows through it and it is placed in a magnetic field perpendicular to its plane. This paper describes experiments that have been made to study the latter effect and to show its essential relation to the Hall effect. The symmetry of the experiment arranged for measuring the Corbino effect, as well as the fact that the measurement of the Hall effect requires very thin sheets, gives to the Corbino effect an important position among the galvanomagnetic effects.

Spontaneous Generation of Heat in Recently Hardened Steel: CHARLES FRANCIS BRUSH.

The writer shows that the specimens of carbon tool steel and tungsten "high speed" steel examined by him spontaneously generated a very considerable amount of heat at room temperature after being water-hardened at cherry-red or white heat; that the development of heat at steadily diminishing rate was observable more than a month, and was accompanied by shrinkage in volume of the steel. Progress of heat generation and of shrinking is shown in curves. But that shrinking is only incident to, and is not the prime cause of the generation of heat is evidenced by the fact that the internal work represented by the heat generated is hundreds of times greater than necessary to produce the observed change in volume.

The writer further shows that in the process of hardening, the steels increased at least a half per cent. in volume, evidenced by specific gravity tests of half-inch bars and linear measurements of long thin rods; that when afterward tempered to light-blue color much shrinkage took place at once, followed by more shrinkage when tempered to light-blue color, and another large shrinkage when annealed.

The writer regards the hardened steel as being in a condition of very great molecular strain somewhat unstable at first. Spontaneous relief of a small portion of the strain causes the generation of heat observed until stability at room temperature

is reached. Any considerable rise of temperature, as in tempering, permits further spontaneous relief of strain, or molecular rearrangement, doubtless accompanied by more generation of heat, and so on until annealing temperature is reached. It is obvious that the process of tempering or annealing steel is an exothermic one, and conversely that hardening is an endothermic process.

Diagrams of the apparatus employed are shown and described, and analyses of the steels given.

Ruling and Performance of a Ten-inch Diffraction Grating: A. A. MICHELSON.

One-Dimensional Gases and the Reflection of Molecules from Solid Walls: ROBERT WILLIAMS WOOD.

Heredity in Protozoa: M. H. JACOBS.

In the higher animals, characters are not for the most part directly *transmitted* from one generation to the next, but develop anew in each generation from the germ-plasm. In the protozoa, on the other hand, there is a mixture of direct transmission and new development that has interesting consequences in the case of the inheritance of newly acquired characters. In this connection a race of *Paramecium* with three contractile vacuoles instead of the usual number of two is discussed, and the means described by which the unusual number is kept from disappearing. The factors concerned seem to be: (*a*) direct transmission of the extra vacuole, (*b*) a tendency to adhere to ancestral racial traits, and (*c*) a new tendency of the protoplasm to produce extra vacuoles.

The Constitution of the Hereditary Material: T. H. MORGAN.

The Problem of Adaptation as Illustrated by the Fur Seals of the Pribilof Islands: GEORGE H. PARKER.

The Alaskan fur-seal is a pelagic animal that breeds in summer on the Pribilof Islands, Behring Sea. About equal numbers of males and females are born. At the breeding age one male, the bull, becomes associated with a number of females, the cows, thus constituting a harem. A harem may contain as many as 120 cows and probably averages about 30. As a result of this disproportionate relationship as compared with the proportion of the sexes at birth, there are to be found at most breeding-grounds many so-called idle bulls. These are a measure of the inefficiency of organic adaptation. Contrary to the opinion held by many biologists, adaptation is not always a relation of great exactitude, but is often, to use the words of Bateson, a poor fit.

An Interpretation of Sterility in Hybrids: EDWARD M. EAST.

Heterosis and the Effects of Inbreeding: GEORGE H. SHULL.

Physiological processes are stimulated and rate of growth and total amount of growth increased through the union of gametes having unlike constitution. This physiological effect of the differences in uniting gametes is heterosis. Inbreeding lessens heterosis by gradually lessening the differences between the uniting gametes. The application of this principle to some of the problems of practical breeding was briefly discussed.

The Significance of Sterility in Œnothera: BRADLEY M. DAVIS.

Studies on the seed, ovule and pollen sterility in *Œnothera* show that there are species with a high degree of fertility and species in which fertility is low, also that hybrids may exhibit a wide range in comparative fertility. These conditions suggest the possibility that hybrids may at times continue indefinitely as impure or heterozygous species through a failure to produce homozygous zygotes or through the mortality of zygotes having homozygous constitutions. *Œnothera Lamarckiana* is a form with low seed fertility and a high degree of pollen and ovule sterility, and may be representative of an impure species, hybrid in character, which for the most part breeds true, but occasionally and repeatedly produces other types, the so-called mutants. In genetical work with Œnotheras a method of germinating seeds must be employed which will give trustworthy proof that a culture has produced all of the seedlings possible from a sowing of seed-like structures.

Morphology and Development of Agaricus rodmani: GEORGE F. ATKINSON.

Agaricus rodmani, which is closely related to the cultivated mushroom, *Agaricus campestris,* has a thick, double annulus, which is divided into an upper and lower limb by a broad, marginal groove nearly reaching the stem. This peculiar annulus, especially the lower limb, has suggested a resemblance to the volva of the Amanitas. While it arises from the surface of the pileus margin, and is composed to some extent of a portion of the blematogen, it is not strictly comparable to the volva, since the blematogen in the species of *Amanita* thus far studied is clearly separated from the pileus by a distinct cleavage layer, while in *Agaricus* it remains "concrete" with the pileus.

The pileus and stem fundaments are differentiated by the appearance of an internal, narrow zone of young, slender hyphæ, rich in protoplasm, the primordium of the hymenophore and pileus margin. These hyphæ are directed obliquely downward.

The rapid increase in the elements of this primordium produces a tension on the ground tissue below it, which now lags behind in growth, so that it is torn apart, forming an annular cavity in the angle between the stem and pileus.

The pileus margin and the hymenophore primordium increase in a centrifugal direction. The palisade stage of the hymenophore begins next the stem. In certain individuals it also extends partly down on the stem. The hymenophore primordium consists of a zone of parallel, slender hyphæ, the ends of which are not crowded, thus presenting a more or less frazzled appearance on its lower surface. The transition to the palisade stage occurs by the increase in number of these hyphæ and the broadening of their free ends.

The lamellæ originate as radial, downward-growing salients of the palisade zone, beginning next the stem, in some individuals also arising on the upper part of the stem. Since the growth and increase of these parts of the hymenophore, as well as that of the pileus margin, is centrifugal, all stages of the young hymenophore are therefore found in a single individual during an intermediate stage of its development; the zone of gill salients next the stem, followed by the palisade zone, and outside of this the primordial zone.

The Large-fruited American Oaks: William Trelease.

Relationships of the White Oaks of Eastern North America: M. V. Cobb.

The Present Need in Systematic Botany: L. H. Bailey.

A Convenient Form of Receiver for Fractional Distillations under Diminished Pressure: Marston T. Bogert.

A simple form of apparatus was exhibited and described which permits the collecting and measuring of fractions of any size and number.

The Cymene Carboxylic Acids: J. R. Tuttle and Marston T. Bogert.

The authors have prepared the two isomeric p-cymene carboxylic acids, p-cymene 2-carboxylic acid and p-cymene 3-carboxylic acid, from the corresponding bromo compounds, by the well-known Barbier-Grignard reaction (metallic magnesium and anhydrous ether, followed by carbon dioxide).

Small amounts of the 2-acid have been obtained heretofore by other investigators, and a few salts have been recorded; but we believe that this is the first time that the acid has been obtained in sufficient amount to be extensively studied. The authors have prepared, in addition to the free acid, various salts, esters and other derivatives.

The isomeric 3-acid appears to be entirely new. Its properties and those of certain of its derivatives are described by the authors.

These acids are members of the benzoic acid series, and this paper is therefore a contribution to our knowledge of a very important group of organic acids.

Syringic Acid and its Derivatives: E. Plaut and Marston T. Bogert.

In the bark and leaves of the lilac (*Syringa vulgaris*), and in the bark of the privet (*Ligustrum vulgare*), there occurs a substance which has been called "syringin," "lilacin" or "ligustrin." When this substance is oxidized with potassium permanganate, it yields glucosyringic acid, and this latter is easily saponified to dextrose and syringic acid.

The authors obtained their syringic acid by the method of Bogert and Isham (treating trimethyl gallic acid with fuming sulphuric acid), and have prepared therefrom and studied a number of new derivatives; among them being bromo, nitro, amino and hydroxy syringic acids, esters, acetyl derivatives, and ortho condensation products.

The Relation of Ductless Glands to Dentition and Ossification: William J. Gies.

Gastro-Intestinal Studies: Philip B. Hawk.

On the Rate of Evaporation of Ether from Oils and its Application in Oil-ether Colonic Anesthesia: Charles Baskerville.

The rate of evaporation of oil-ether mixtures containing 25, 50 and 75 per cent. of the latter was determined at body temperature. The oils used were olive, peanut, corn, cottonseed, soya bean, cod liver and lanolin.

The speed at which the ether evaporated from the 75 per cent. mixture was found clinically to be the best for introducing and maintaining anesthesia in the human subject by insertion in the colon. The technique is indicated for operations about the head, throat, mouth and the buccal cavity.

Dr. Gwathmey, the senior colaborator has records of over a thousand cases with different operators without a single case of post-anesthesia pneumonia and with nausea reduced to the minimum.

Oral Endamebiosis: ALLEN J. SMITH.

Certain Factors Conditioning Nervous Responses: STEWART PATON.

The Rights and Obligations as to Neutralized Territory: CHARLEMAGNE TOWER.

Physiographic Features as a Factor in the European War: DOUGLAS W. JOHNSON.

The paper describes the salient features of geological structure west of the Rhine and explains the influence of this structure upon surface topography. Special attention is given to the Rhine graben and the strong contrast between the steep eastern and gentle western slope of the Vosges; the maturely dissected peneplane of western Germany and the Ardennes, trenched by the incised meandering valleys of the Rhine, Moselle and Meuse; the concentric cuestas northeast and east of Paris with their steep escarpments facing toward the Germans; and the comparatively level plains of central and northwestern Belgium. In the eastern field the East Prussian lake district, the plain of Poland, the Podolian cuesta and the Carpathian Mountains are briefly described.

It is shown that in both theaters of war landforms have exercised an important influence both upon the general plans of campaign and the detailed movements of armies. Topography limited the German invasion of France to four principal routes, which are described and illustrated by lantern views. The violation of Belgian neutrality had a very distinct topographic basis. Russia's plan of campaign has been dictated in part by topographic considerations, and the principal battles in the east have been fought with reference to natural lines of defense which are illustrated by diagrams. Suggestions are made as to the effect of landforms upon probable future movements of the armies.

Tammuz and Osiris: GEORGE A. BARTON.

The Pronouns and Verbs in Sumerian: J. DYNELEY PRINCE.

Opium in the Bible: PAUL HAUPT.

In ten passages of the Old Testament Hebrew *rôsh,* head, denotes a bitter and poisonous plant. It is used also of the poison of serpents. According to Pliny the venom of snakes was nothing but bile. The ancients used the same word for gall, bitterness, poison, medicine. We use "to drug" for "to narcotize," although "drug" originally means simply a dry (German *trocken,* Dutch *droog*) herb. *Rôsh* is mentioned in the Bible in connection with *la'anâh,* wormwood or absinthe. It was a plant which grew in the furrows of the fields (Hosea, x., 4). The Authorized Version renders "hemlock," but *rôsh,* head, denotes poppy-head, and *mê-rôsh* is opium. Also the gall (*i. e.,* bitter fluid) with wine (not vinegar) in the account of Christ's crucifixion (Matthew, xxvii., 34) and the myrrh in Mark xv., 23 denote opium. The Talmud states that a cup of wine with *lebonâh* was given to criminals before their execution. *Lebonâh* means "incense," as a rule, but in this case it is used for opium. In the fifth chapter of the Alexandrian festal legend for the feast of Purim, known as the Third Book of the Maccabees, we read that wine with incense was given to the elephants before they were let loose upon the Jews. This "incense" may have been a preparation of Indian hemp. Assassin means intoxicated with hashish (*Cannabis Indica*).

Divisions of the Pleistocene of Europe and the Periods of the Entrance of Human Races: HENRY FAIRFIELD OSBORN.

The Occurrence of Algæ in Carbonaceous Deposits: CHARLES A. DAVIS.

On account of their generally small size and fragile structure, Algæ have not usually been recognized as important contributors to carbonaceous rocks, and some recent students of the microscopic structure of coals have denied the probability of their existence as fossils in carbonaceous rocks. Under certain conditions of deposition and preservation, as yet unknown, Algæ may constitute a large percentage of the recognizable plant remains which have accumulated to form beds of carbonaceous shales of great extent and thickness. Some micro-photographs of Algæ from the oil-yielding shales of Green River age was shown.

Additions to the Fauna of the Lower Pliocene Snake Creek Beds, Nebraska: W. J. SINCLAIR.

The Snake Creek beds explored by the Princeton Expedition of 1914 are found in the northwest corner of Nebraska in Sioux Co., and consist of unconsolidated gravels and sands in which water-worn bones of a large number of fossil animals of Lower Pliocene age are found. Most of these remains are fragmentary and there is almost no association of parts. We were fortunate in securing rather better material than has hitherto been collected from this formation, and have a number of new forms now described for the first time. Most of the remains are of horses, of which there were at least a dozen different species on the Lower Pliocene plains of Nebraska, most of them three-toed. There were also several different kinds

of camels, some of them quite large, at least three rhinoceroses, many carnivorous animals, some of large size, at least two mastodons, a peccary, the last of the oreodons or "ruminating hogs" as Professor Joseph Leidy called them, an antelope of entirely new type, quite different from anything hitherto reported from North America, with scimitar-shaped horns sloping backward and curving inward, circular at the base but flattening out toward the tips. There is still another antelope, *Dromomeryx*, but no trace of the pronghorn. In collections made by the American Museum from the Snake Creek beds the first of the bisons appears, so the Snake Creek fauna gives us some idea of the kinds of animals on the buffalo range when the buffalo first came, and shows what great faunal changes have taken place even during the lifetime of this genus.

The Rôle of the Glacial Anticyclone in the Air Circulation of the Globe (illustrated by lantern slides): William H. Hobbs.

The paper presents in outline a theory of nourishment of the great continental glaciers of the polar regions, and shows in what ways this theory, first promulgated by the author in 1910, has been confirmed and extended by the work of the numerous exploring expeditions carried out since that date. It is particularly because the expeditions across Greenland of 1912 (deQuervain) and of 1913 (Koch and Wegener), and those of Scott and Amundsen into the heart of the Antarctic continent, have for the first time penetrated the central areas of continental glaciers that the newer studies are illuminating. The penetration of higher levels of the atmosphere upon the borders of the inland ice through the aid of pilot balloons, has supplied further evidence of great value along a wholly new direction. Most recent of all, the studies of Sir Douglas Mawson within a new section of the Antarctic continental glacier has brought valuable confirmatory observations.

Note on the Sun's Temperature: Henry Norris Russell.

The effective temperature of the sun may be computed from Abbot's data for the radiation of each separate wave-length, using Planck's formula. The resulting temperature at the center of the disk is about 6600° when determined from the visible radiation, but 600° lower according to the radiation in the infra-red. The effective temperature at the edge of the sun is more than 1000° lower, which accords with the theory that at the center of the disk we can see down deeper, into hotter layers.

Some Results from the Observation of Eclipsing Variables: Raymond S. Dugan.

Slides showing observed light-curves of three giant eclipsing variables: RT Persei, Z Draconis and RV Ophiuchi; and diagrams of the binary systems whose revolution is supposed to give rise to the observed light variations. The importance of repeatedly observing the entire period shown in the discovery of shallow secondary minima, the oblateness of the stars, inter-radiation and periastron effects and darkening toward the limb. Evidence of the greater brilliance of the advancing side of the bright star. The variation of the periods of these three stars. Early Harvard photographs and recent photometric observations extend the observations of Z Draconis over nearly 7000 periods and of RT Persei over nearly 11,000 periods. Comparison of the visual and photographic light curves.

The Variable Stars TV, TW and TX Cassiopeiæ: R. J. McDiarmid.

A brief discussion of the light curves of the variable stars TV, TW, TX Cassiopeiæ and T Leonis Minoris was given, pointing out interesting features in connection with each system.

In the system TV Cass. we have two stars of nearly the same size but of different surface brightness, the ratio being 5.5 as to 1.0. In this system other points of interest are brought out, such as the reflection and ellipticity effects. The system TW Cass. represents two stars of almost equal brightness and of nearly the same size, moving in an eccentric orbit. In the third system TX Cass. the two stars are very unequal in size, with a ratio of surface brightness of 1.0 to 1.5. The stars are ellipsoidal in shape, giving rise to an ellipticity effect shown by the light curve. The system is of special interest, as there seems to be little doubt of its being similar to the sun, bright at the center, decreasing in brightness toward the limb. T Leonis Minoris is an eclipsing variable. The ratio of the surface of the two stars in the eclipsing system T. Leonis Minoris is 1 as to 25.

Radial Velocities in the Orion Nebula: Edwin B. Frost.

The investigations of the nebula in Orion by Messrs. Bourget, Fabry and Buisson, of Marseilles, published in the *Astrophysical Journal* for October, 1914, show that the photographic interferometer method can be successfully applied to the study of the radial velocities of the nebula,

both as a whole and in its separate parts. Their conclusions that there are very appreciable motions in closely adjacent portions of the nebula have been confirmed by observations made in the last few weeks with the Bruce spectrograph. Differences of over 10 km. per second in the velocity in the line of sight have been found, and the general effect of rotation of the nebula inferred by the French observers is confirmed by the spectrograph.

The Euler-Laplace Theorem on the Rounding Up of the Orbits of the Heavenly Bodies under the Secular Action of a Resisting Medium: T. J. J. SEE.

HORACE CLARK RICHARDS

THE AMERICAN PHYSICAL SOCIETY

A REGULAR meeting of the American Physical Society was held at the National Bureau of Standards, Washington, on Friday and Saturday, April 23 and 24, 1915.

Friday, 2 P.M.

Hon. William C. Redfield, Secretary of Commerce, opened the meeting with a cordial address of welcome in which he gave strong expression to his interest in the progress of science, and his appreciation of the vital interdependence of physics and the commercial interests of the country.

Papers were presented as follows:

"On the Distributed Capacity of Single Layer Solenoids," by J. C. Hubbard. (By title.)

"The Skin Effect in Bimetallic Wires," by John M. Miller.

"Magnetization by Rotation," by S. J. Barnett.

"Intercomparisons of the Standard Instruments at Magnetic Observatories 1905–1914," by L. A. Bauer.

"Simultaneous Readings in Electrical Measurements, with Demonstration of a New Type of Switch for Facilitating Them," by Walter P. White.

"The General Design of Critically Damped Galvanometers," by Frank Wenner. (By title.)

"Apparatus for the Simultaneous Measurement of Length, Electrical Resistance, and Magnetic Permeability as Functions of the Temperature," by Arthur W. Gray. (By title.)

"The Dielectric Constant of a Heterogenous Dielectric," by H. L. Curtis and M. James.

"The Separately Excited Electrodynamometer as a Sensitive Galvanometer," by Ernest Weibel.

"The Crushing of a Hollow Conductor by Lightning," by W. J. Humphreys. (By title.)

"Aneroid Barometers," by M. D. Hersey.

"A Method of Measuring Heat Conductivities," by R. W. King.

"Viscosity of Ethyl Ether near the Critical Temperature," by A. L. Clark.

"An Equation of State for Normal Substances, Tested in the Vapor Dome," by Harvey N. Davis.

"The Correction of Echoes in the Auditorium at the University of Illinois," by F. R. Watson. (By title.)

"The Transpiration of Plants in Relation to Temperature and Solar Radiation," by Lyman J. Briggs and H. L. Shantz.

"A Mercurial Barometer in which the Well Setting is Eliminated," by Lyman J. Briggs.

Saturday, 9:30 A.M.

"The Reflecting Power of Metals for the Ultra-Violet Region of the Spectrum," by Edward O. Hulburt.

"The Visibility of Radiation in the Red End of the Visible Spectrum," by Edward P. Hyde and W. E. Forsythe.

"The Effective Wave-Length of Transmission of Red Pyrometer Glasses and other Notes on Optical Pyrometry," by Edward P. Hyde, F. E. Cady and W. E. Forsythe.

"The Use of a Hollow Filament with Perforations in the Determination of the Black-body-Temperature and True-Temperature Relation for Tungsten," by A. G. Worthing.

"A Further Extension of the Spectrum in the Extreme Ultra-Violet," by Theodore Lyman.

"The Fluorescence and Absorption Spectra of Uranyl Nitrate," by E. L. Nichols and Ernest Merritt.

"A Precision Artificial Eye," by Herbert E. Ives. (By title.)

"A Flicker Photometer Attachment for a Lummer-Brodhun Photometer Head," by E. F. Kingsbury.

"Color Grading and Color Specifications by Means of the Rotary Dispersion of Quartz," by Irwin G. Priest and Chauncey G. Peters. (By title.)

"A Proposed Method for the Photometry of Lights of Different Colors," by Irwin G. Priest.

"On X-ray Wave-lengths," by William Duane and F. L. Hunt.

"The X-ray Spectrum of Tungsten at Constant Potential," by David L. Webster.

"Factors Governing the Darkening of a Photographic Plate by X-rays," by J. S. Shearer.

"The Wave-length Sensibility Curve for Isolated Crystals of Selenium between 200 $\mu\mu$ and 450 $\mu\mu$," by L. P. Sieg and F. C. Brown.

"The Variation of Equilibrium Conductivity of Selenium with the Intensity of Illumination," by F. C. Brown.

"The Effect of Variation of Temperature on the Coefficient of Recombination of Electrons in Selenium Crystals," by Kathryn J. Dietreich.

Saturday, 2 P.M.

"A Null Method with Photo-electric Cells," by F. K. Richtmyer.

"New Tests of Einstein's Photo-electric Equation," by R. A. Millikan.

"Factors Affecting the Relation between Illumination and Photo-electric Current," by Herbert E. Ives, Saul Dushman and E. Karrer.

"The Theory of Adsorption," by Irving Langmuir.

"The Law of Stokes and the Removal of Particles from Fluids," by W. W. Strong.

"Ionization Potential of an X-ray Tube," by E. C. Drew. (Introduced by Horace C. Richards.)

"Parson's Magneton Theory of Atomic Structure," by David L. Webster.

"A Conducting Paint," by M. James.

"Mechanical Strain and Thermo-electric Power," by Walter P. White.

"Recent Results and Conclusions Regarding Specific Heats at Moderate and High Temperatures," by Walter P. White. (By title.)

"Geometrical Tripods and Stands," by Lyman J. Briggs.

"Changes in Electrical Resistance Accompanying Thermal Expansion," by Arthur W. Gray.

"The Ballistic Use of a Moving Coil Galvanometer in Measuring Discharges Obeying the Exponential Decay Law," by A. G. Worthing.

"The Mobilities of Ions in Air," by E. M. Wellisch.

"The Effect of a Magnetic Field on the Initial Recombination of the Ions Produced by X-rays," by J. E. M. Jauncey. (By title.)

"An Accurate Method for the Measurement of the Conductivity of Electrolytes," by W. A. Taylor and H. L. Curtis. (By title.)

The thanks of the society were extended to the Washington members for the lunch generously provided on Saturday for all visiting physicists and to the Bureau of Standards for numerous courtesies extended.

On Friday evening a large number of the members in attendance dined together at the Cosmos Club. This pleasant feature was arranged for and carried out by Dr. L. J. Briggs of the Bureau of Plant Industry.

The attendance at all sessions was good, and there was considerable profitable discussion of papers. On account of the length of the program, a number of local members courteously yielded their time to others and presented their papers by title only.

A. D. Cole,
Secretary

THE ENTOMOLOGICAL SOCIETY OF AMERICA

The ninth annual meeting of the Entomological Society of America was held at the University of Pennsylvania on December 31, 1914, and January 1, 1915, in affiliation with the American Association for the Advancement of Science. The meetings were all well attended, but from the shortness of the time and the amount of business to be transacted several papers had to be read by title.

The annual public address was delivered on Wednesday evening, December 30, at the Academy of Natural Sciences by Professor Stephen A. Forbes, of the University of Illinois, on the subject: "Ecological Foundations of Applied Entomology." At the same meeting Dr. Henry Skinner, of the Academy of Natural Sciences, gave "A History of the Entomological Society of America." The visiting entomologists were entertained by the local entomologists at a smoker after the addresses.

The following papers were presented:

"Food Habits of Some Colorado Aphids," by C. P. Gillette.

"The Poison Glands of *Automeris io* Fabr.," by Cornelia F. Kephart.

"Geographical Distribution of Neuropteroid Insects, together with Analysis of Our Insect Fauna," by Nathan Banks.

"The Biology of *Nymphula maculalis* Clemens," by Paul S. Welch. Read by title.

"Modification of Tiger-beetle Colors by Temperature and Moisture," by V. E. Shelford.

"Life-history, Development and Work of Unspotted Tentiform Leaf-miner of Apple," by L. Haseman. Read by title.

"Pupal Characters Used in the Classification of the Sphingidæ," by Edna Mosher. Presented by the secretary.

"Results of Twenty-five Years' Collecting of the Tachinidæ," by J. M. Aldrich.

"Notes on Capsid Life-histories," by Mortimer D. Leonard.

"Notes on the Life-histories of Certain Membracidæ," by W. D. Funkhouser.

"A Photographic Record of the Development of the Female *Lepidosaphes ulmi* Linn.," by R. A. Cooley.

"On Proper Generic Concepts," by C. H. Tyler Townsend.

"The Homology of the Genitalia of *Benacus griseus*," by Anna Grace Newell.

"The Nemocera not a Natural Group of Diptera," by Frederick Knab.

"Studies on the Morphology of the Head and Mouth-parts of Diptera," by Alvah Peterson. Read by title.

"Interpretation of the Codling-moth Data from Colorado," by C. P. Gillette.

"Modification of the Color Patterns of *Cicindela* by Temperature and Moisture," by V. E. Shelford. Read by title.

"Suggestions for Discovering Affinity and Phylogeny," by Nathan Banks.

"Insect Notes from Colorado," by C. P. Gillette.

"The Modification of the Subcostal Vein in the Wings of Insects," by Alex. D. MacGillivray. Read by title.

"The Olfactory Sense of Coleoptera," by N. E. McIndoo.

"The Ecology of Plague," by James Zetek. Read by title.

"Importance of Observations Apparently Unimportant," by F. M. Webster. Read by title.

"Life-history Studies on the Cercopidæ and Jassidæ," by Herbert Osborn.

"An Insect Enemy of the Four-lined Leaf-bug," by C. R. Crosby. Read by title.

The greater part of the morning of the first was devoted to the business meeting at which was reported the election of Rev. Charles J. S. Bethune, Professor John Henry Comstock, Professor Charles Henry Fernald and Mr. Eugene Amandus Schwarz as honorary fellows.

The following members were elected as fellows: Nathan Banks, J. Chester Bradley, W. E. Britton, C. T. Brues, H. T. Fernald, Glenn W. Herrick, J. S. Hine, O. A. Johannsen, A. L. Melander, A. P. Morse, P. J. Parrott, Edith M. Patch, A. L. Quaintance, J. A. G. Rehn, W. A. Riley, Annie Trumbull Slosson, E. M. Walker, H. F. Wickham and E. B. Williamson.

One of the most important features of the meeting was the establishment of the Thomas Say Foundation. A serial for the publication of works dealing with American systematic entomology of such size as to preclude of their publication in the ordinary channels. The publication was placed in the charge of a temporary committee consisting of J. M. Aldrich, Nathan Banks, Morgan Hebard, E. P. Van Duzee and Alex. D. MacGillivray.

The following officers were elected for 1915:

President—Professor Lyman V. Kellogg, Leland Stanford Junior University.

First Vice-president—Professor James S. Hine, Ohio State University.

Second Vice-president—Mr. J. M. Aldrich, U. S. Bureau of Entomology.

Secretary-treasurer—Alex. D. MacGillivray, University of Illinois.

Additional Members of the Executive Committee—Mr. C. T. Brues, Bussey Institution; Professor William A. Riley, Cornell University; Professor T. D. A. Cockerell, University of Colorado; Mr. J. A. G. Rehn, Philadelphia Academy of Natural Sciences, and Professor A. L. Melander, Washington Agricultural College.

Member of Committee on Nomenclature—Nathan Banks, U. S. Bureau of Entomology.

The society decided to hold a summer meeting in August at San Francisco in affiliation with the American Association and the annual meeting in December at Columbus.

ALEX. D. MACGILLIVRAY,
Secretary

INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science held its thirtieth annual meeting in Indianapolis, December 4–5. The attendance was the largest and the interest the greatest in many years. Over 100 new members were added to the roll this year. The following papers were presented:

"Science in Its Relation to Conservation of Human Life," address by the retiring president, Mr. Severance Burrage.

Symposium: Some Scientific and Practical Aspects of the Problem of Feeble-mindedness.

"The Feeble-minded Family," by Amos W. Butler.

"The Problem of Feeble-mindedness," by Dr. G. S. Bliss.

"The Feeble-minded and Delinquent Boy," by Dr. F. E. Paschal.

"The Feeble-minded and Delinquent Girl," by Dr. E. E. Jones.

"Feeble-mindedness in the Public School," by Miss Katrina Myers.

"The Alcohol Problem in the Light of Coniosis," by Robert Hessler.

"Cold Storage, Practical Conservation," by H. E. Barnard.

"Changing Conditions among the Cumberland Plateau Mountain People" (lantern), by Bernard H. Schockel.

"The Conservation of Energy," by Arthur L. Foley.

"Agriculture in Southern Indiana," by C. G. Phillips.

"The Chief Reason for the Migration of Our Birds," by D. W. Dennis.

"An Aeration Apparatus for Culture Solutions," with charts, by Paul Weatherwax.

"Antagonism of *B. fluorescens* and *B. typhosus* in Culture," by P. A. Tetrault.

"Notes on the Distribution of the Forest Trees of Indiana," by Stanley Coulter.

"A New Enemy of the Black Locust," by Glenn Culbertson.

"The Parasitic Fungi Attacking Forest Trees in Indiana," by Geo. N. Hoffer.

"A New Disease of *Viola cucullata*" (lantern), by H. W. Anderson.

"Oatsmut in Indiana," by F. J. Pipal.

"Weed Seeds in Soil," by F. J. Pipal.

"Additions to Indiana Flora," by Chas. C. Deam.

"Some Peculiarities in *Spirogyra dubia*," by Paul Weatherwax.

"Stomata of *Trillium nivale*," by F. M. Andrews.

"Final Report on Cross Pollination of Corn," by M. L. Fisher.

"The Primrose-leaved Violet in White County" (charts and specimens), by Louis F. Heimlich.

"Continuous Rust Propagation without Sexual Reproduction," by C. A. Ludwig.

"Correlation of Certain Long-cycled and Short-cycled Rusts," by H. C. Travelbee.

"Some Species of Nummularia Common in Indiana," by C. E. O'Neal.

"The Genus *Eosellinia* in Indiana," by Glenn B. Ramsey.

"Cultivating and Breeding Medicinal Plants" (lantern), by Fred A. Miller.

"Some Large Botanical Problems," by J. C. Arthur.

"The Alba Gehre Collection of Birds' Eggs in the Museum of Purdue University," by Howard E. Enders.

"A Study of the Maturation Period in the Mole-cricket" (blackboard), by F. Payne.

"Note on a Peculiar Nesting Site of Chimney Swift," by Glenn Culbertson.

"Mosaics in *Drosophila ampelophila*" (chart), by Horace M. Powell.

"New Mutations in the Genus *Drosophila* and their Behavior in Heredity" (chart), by Roscoe R. Hyde.

"Notes on Indiana Earthworms," by H. V. Heimburger.

"Insects of the Between-tides Zone," by Chas. H. Arndt.

"Regeneration in *Sagartia*," by D. W. Davis.

"The Relation of Birds to Aquatic Life as Exemplified by Observation and Studies made at Lake Maxinkuckee," by Barton W. Evermann.

"The Reptiles and Batrachians of the Lake Maxinkuckee Region," by Barton W. Evermann.

"A Physical and Biological Survey of Lake Maxinkuckee," by Barton W. Evermann.

"The Quantitative Determination of Copper," by W. M. Blanchard.

"The Alundum Crucible as a Substitute for the Gooch Crucible," by George L. Clark.

"Some Recent Work in Dairy Chemistry," by George Spitzer.

"Analysis of Zirconium Minerals," by James Brown.

"Correlation of High School and College Chemistry," James Brown.

"Chemical Composition of Virgin and Cropped Indiana Soils," by S. D. Conner.

"Sewage Disposal" (lantern), by Charles Brossmann.

"Extension of Empirical Curve by the Addition of Estimated Values to a Series of Observations" (chart), by Albert Smith.

"Tar-forming Temperatures of American Coals" (charts), by O. C. Berry.

"Shawnee Mound, Tippecanoe County, A Glacial Alluvial Cone" (charts and photographs), by William A. McBeth.

"Flood Prevention in Indiana," by W. H. Hatt.

"Stratigraphic Correlation of the Outcrop at Spades, Indiana," by H. N. Coryell.

"Pennsylvania Fossil Plants of the Bloomington Quadrangle," by J. F. Jackson.

"Preliminary Geological History of Dearborn County," by A. J. Bigney.

"Notes on the Cause of Asterism in 'Staro-lite'" (Asteriated Quartz) (charts and specimens), by J. W. Beede.

"The Mississippian Section of Monroe County" (charts), by J. W. Beede.

"The Flatwoods Region of Owen and Monroe Counties, Indiana," by Clyde A. Malott.

"Mechanical Device for Testing Mersenne Numbers for Primes," by Thomas E. Mason.

"Some Properties of Binomial Coefficients," by A. M. Kenyon.

"The Watertown, S. D., Tornado of June 23, 1914," by J. Gladden Hutton.

"A New Lantern and Projector" (lantern), by Arthur L. Foley.

"Some Text-book Inconsistencies," by Arthur L. Foley.

"The Mechanism of Light and Heat Radiations," by James E. Weyant.

"A Simple Form for the Carey Foster Bridge" (lantern), by J. P. Naylor.

"The Change of the Radioactivity of Certain Springs" (lantern), by R. R. Ramsey.

"Radioactivity of Spring Water" (lantern), by R. R. Ramsey.

"A Radioactive Electroscope" (lantern), by Edwin Morrison.

"Some Results of the Indiana University Lake Survey," by Will Scott.

"Report on Nett Lake," by A. B. Reagan.

"Universal Cement Fence-Post," by F. W. Gottlieb.

A. J. Bigney,
Secretary